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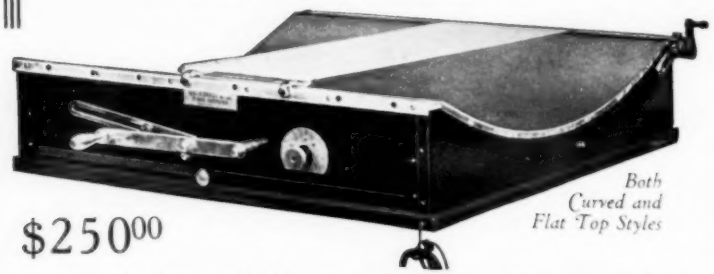

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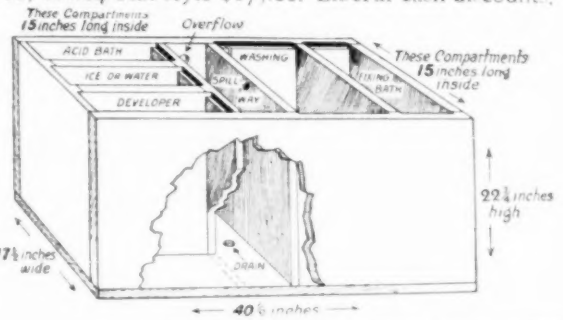

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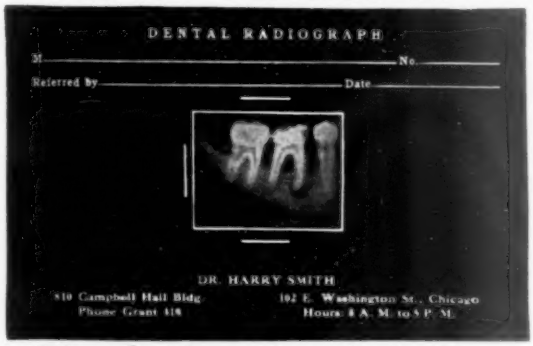

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. XVI DECEMBER, 1926 No. 6

THE DEVELOPMENT OF FILTERED RADON IMPLANTS*

BY G. FAILLA, D.SC.

Memorial Hospital

NEW YORK CITY

I. HISTORICAL

EARLY in the development of radium therapy it was realized that some tumors were very resistant to radiation, and could not be treated effectively by external applications alone. Accordingly some of the pioneers (Strebel, Abbe,[2] Morton, 1906) resorted to the method of inserting the radioactive source into the tumor mass. At first only bulky radium containers were available for this purpose. Then Stevenson[3] and Joly effected a great improvement in the technique by utilizing concentrated radon (radium emanation) as the radioactive source. They collected the radon in very fine capillary glass tubes which they placed in hollow metallic needles. These were then inserted into the tumor to be treated, and were withdrawn at the end of the exposure. Since radon was available in only a few institutions at the time, this procedure was not employed very extensively. It led, however, to the manufacture of "radium needles" made of steel or platinum. By using pure radium sulphate, little space was required for a radioactive source of 5 or 10 milligrams of radium, and the needles could be made quite small. Such needles made the method of Stevenson and Joly available to the average radiologist.

In the methods of intratumoral irradiation discussed so far, the radioactive source was allowed to remain within the tumor mass for a certain time, and then was withdrawn. A different procedure was first suggested by Duane[4] in which advantage is taken of the relatively short life of radon. It consists in the collection of the radioactive gas in tiny glass tubes which are discharged by a small trocar into the tumor mass, and are allowed to remain *in situ* indefinitely. This method possesses the great advantage of simplicity, in addition to other intrinsic merits. Originally Duane advocated it for three main reasons: (1) utilization of beta rays; (2) irradiation of the tumor mass for a considerable period of time, and (3) reduction of trauma. The practical technique of this method was first worked out at the Memorial Hospital by the late Dr. H. H. Janeway,[5] who employed it extensively. It proved very successful in the treatment of certain lesions, particularly around the mouth, which until that time had yielded poor results by all other methods of radium treatment.

Janeway's early work with "bare tubes," while showing the effectiveness of the method, revealed also its chief objectionable feature. The treatment caused

* Most of the material collected in this paper was presented first at the International Congress of Radiology,[1] held in London in July, 1925; then at the Eleventh Annual Meeting, AMERICAN RADIUM SOCIETY, Dallas, Texas, April 19 and 20, 1926.

severe pain and other discomforts for a considerable period of time. This could be traced to the intense necrosis produced in the neighborhood of each bare tube. In view of the low penetrating power of the beta rays it was evident that the necrosis was due chiefly to this radiation. A simple analysis of the problem revealed, also, that the gamma radiation was really responsible for the good clinical results obtained by this method. Direct evidence supporting this view was obtained by Regaud[6] at the Radium Institute in Paris. Regaud has always advocated the use of gamma radiation for therapeutic purposes, and the methods of treatment which he has developed have all been based on this principle. Furthermore, from experimental evidence, he concluded that certain types of cancer could be treated more effectively by radiation of low intensity applied continuously for a relatively long period of time.[7] In view of these considerations, Regaud developed a technique which has been used extensively at the Radium Institute and has yielded very good results in mouth cancer. The principal characteristics of this method are: (1) the use of radium needles of small radium content in which (2) the primary beta radiation is removed by a filter of 0.5 mm. of platinum, (3) the needles being left in the tumor continuously for one week or ten days. To make sure that the needles remain in place during the whole treatment, they are first inserted into the tumor, and then they are sewed to the tissue with a suitable thread. It has been found that with this method good final results are obtained with little or no necrosis resulting from the irradiation.

It will be readily seen that from a practical point of view the Regaud method is not so convenient as the bare tube method. Either has advantages and disadvantages, and the real test is which one gives the largest percentage of good final results. This question, however, cannot be settled easily. Analyzing the problem we find that the principal merit of the Regaud method is due to the elimination of the primary beta radiation. On the other hand, the presence of this radiation constitutes the chief objection to the use of bare tubes. A combination of the two methods, embodying the advantages of each, would obviously be desirable. To accomplish this, it is necessary to filter out the beta rays from each tube which is to be left permanently in the tissue. Remembering that a filter of at least 0.4 mm. of platinum, or its equivalent is necessary to remove all the beta radiation, it will be seen that "implants" or "seeds" of this type would have to be considerably larger than the bare tubes ordinarily employed. Is it permissible to leave permanently in a patient tubes of about one millimeter diameter? This question would be answered differently by different radiologists. Obviously, however, it is desirable to use implants as small as possible in order to cause little mechanical trauma, both at the time of insertion and subsequently. It will be seen that it is a matter of choice between the undesirable effects of the beta radiation and of mechanical trauma. It will be shown later how a satisfactory compromise can be made between these two antagonistic factors.

At this point, however, it is well to mention an ingenious scheme devised by Heublein[8] for decreasing the necrosis produced by bare tubes. Knowing that tissue necrosis is practically limited within a radius of a few millimeters around a bare tube, Heublein conceived the idea of surrounding each tube in the tissue with a comparable thickness of bismuth paste. He was able to do this by means of a specially constructed syringe and needle. Theoretically the method has several good points: (1) A needle of small diameter suffices to insert the bare tube into the tissue; (2) the same needle is used to inject the bismuth paste; (3) the paste serves as a filter and then is gradually eliminated by the system, and (4) the position of the radioactive sources in the tissue can be ascertained by taking a roentgenogram. However, extensive tests carried out by Heublein and Quick at the Memorial Hospital revealed that considerable necrosis was still present; that owing to irregularities in the tissue, the bismuth paste was not distributed evenly around the bare tube, but in fact was apt to be concentrated on one side; and that the bismuth remained in the tissue for months. It

became evident then that further development of the method was necessary, but the work was interrupted because of the successful preparation of small filtered implants.

Before describing this work another clever device for intratumoral therapy should be mentioned here. The scarcity of radium in Germany led Halberstädter[9] to the adaptation of one of the thorium disintegration products for interstitial use. Thorium x has a average period of life of 5.25 days, which is very close to that of radon, 5.5 days. However, while radon is a gas, thorium x is a solid, and therefore the preparation of small sources for intratumoral irradiation is quite different. A serious difficulty is due to the fact that thorium x is very toxic. Halberstädter and Wolf finally succeeded in making a suitable insoluble preparation which can be drawn into a fine rod. Short sections of this rod, or filament, can then be used in the same way as the glass tubes containing radon. The radiation emitted by the thorium x rods consists of alpha, beta, and gamma rays, the first being present in negligible amounts. Furthermore, owing to the barium sulphate which is mixed with the thorium x in the preparation of the rods, a part of the beta radiation is filtered out. The amount which is emitted, however, is sufficient to cause considerable necrosis.

Going back now to the discussion of radon implants, we shall mention briefly our early attempts at the problem of absorbing out the beta radiation, wholly or in part. Since it is a simple matter to collect radon in glass tubes, the most obvious procedure is to use lead glass tubing. We did this several years ago, but animal experiments carried out by Leddy proved that the filtering power of the lead glass tubes was insufficient. The thickness of the lead glass required to remove a considerable percentage of the beta radiation would make the tubes too big for interstitial use. Uranium glass is procurable, but the uranium content is too small to be effective, and we could not get a special uranium glass made. Accordingly we turned our attention to the use of a metallic filter.

Our first idea was to inclose a glass implant in a small platinum tube and insert the whole into the tissue by means of a trocar. We used platinum of different thicknesses (0.15 to 0.4 mm.) and conducted animal experiments with the coöperation of Dr. Leddy. In this work some tubes were left in the animal until it was sacrificed, and others were removed at different intervals. The results showed that the amount of necrosis could be greatly reduced by using platinum filters. Of necessity, however, the filtered implants were considerably larger than the glass tubes, and the trocar had to be considerably larger in diameter. The question of trauma, therefore, assumed greater importance. In order to make filtered implants of the smallest possible size, it was evident that the radon should be collected directly in a metal tube, and we directed our efforts towards this ideal.

II. PREPARATION OF METAL IMPLANTS

It is well known that the most effective filter is one having the highest atomic weight and density. Of the available metals, iridium, platinum, and gold are the most suitable for this purpose. Their atomic weights are 193.1, 195.23, and 197.2, while their densities are 22.42, 21.37, and 19.33 respectively. Experiments conducted in our laboratory by Quimby[10] to determine the absorption of radium radiations by different metals, showed that equal thicknesses of platinum and *pure* gold had the same absorbing power, within the limits of experimental error. This being the case, gold is preferable because it is about one-fifth as expensive as platinum. Accordingly we had some capillary gold tubing made by Baker and Company.

The apparatus used for the collection of radon at the Memorial Hospital has a two-way glass stopcock which enables us to collect the day's supply of radon in two separate containers in any proportion we please. Ordinarily two capillary glass tubes of different diameters are used as containers. Our first problem, therefore, was to substitute a gold capillary for one of the glass tubes. This can be done very simply by the following procedure: A

glass tube 9 mm. in diameter is drawn down so that the inside diameter of the middle portion is a little smaller than the outside diameter of the gold tube. The latter is then inserted into the tapered portion of the glass tube to determine the point of contact, and one end of the constricted tube is cut off about 2 mm. beyond this point. To make the joint gas tight, a small amount of DeKhotinsky* cement is melted into, and around, the space between the gold and glass tubes. A cross section of the joint is shown in Figure 1. The glass tube can then be sealed

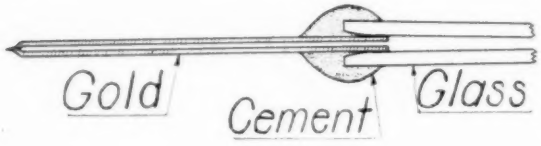

FIG. 1.

to the two-way stopcock in the usual manner.

The amount of radon in equilibrium with one gram of radium (1000 millicuries) occupies a volume of 0.6 cubic millimeter at standard pressure and temperature. Since an implant ordinarily would not contain more than a few millicuries, the space required for the pure radon is very small,—a few thousandths of a cubic millimeter. However, liberal allowances must be made for impurities, and it is also desirable to have the gas in the tube at less than atmospheric pressure. The first pure gold tubing we tried had a bore of 0.2 mm., and it was found to be larger than necessary. Later we tried tubing of 0.1 mm. bore, but in general we have been using tubing of 0.15 mm. bore.

In order to collect radon in such a small tube, it must be possible to seal the free end hermetically so that the tube can be thoroughly exhausted before forcing the purified radon into it. Then it must be possible to seal the other end, and finally the tube must be divided into short lengths without the loss of radon at any stage of the process or subsequently. This part of the problem gave us considerable trouble, but we finally succeeded in making gas tight seals by a very simple device. Pure gold, being quite soft, and the bore of the tubing being very small, we found that a gas tight seal could be made by simply pinching the tubing. For this purpose we use an ordinary pair of pliers whose cutting edges have been purposely dulled. Radon implants made in this manner can be boiled for one hour or more without loss of radon. From this point of view the method is very satisfactory, but one might object to the chisel-like ends of the tubes thus cut. We have tried many different schemes to round the ends, but so far we have found no simple means of doing this. At the present time we are making a machine which we feel confident will accomplish the desired result by cutting the tubes initially with round ends.

The actual process of making gold implants is as follows: A gold tube of sufficient length to make the required number of implants is attached to the collection apparatus. The free end of this tube is pinched, and a little cement is melted around it to make doubly sure that the seal is gas tight.* Then the air is pumped out and purified radon is forced into the tube by means of a Toepler pump arrangement, the mercury being raised almost to the point of contact of the gold and glass tubes. Using suitable pliers, the whole length of gold tubing is then cut off, and divided into sections about 6 mm. long. It should be noted in this connection that if the cutting is done from one end to the other the sections cut last contain more radon than the first ones. If tubes of equal radon content are desired, the tubing should be subdivided by successive bisections. Using the procedure outlined above for sealing the gold to the glass tubing and cutting off the long gold capillary after it has been filled, a small amount of radon is left back in the space between the top of the mercury column and the projecting end of the gold tubing which remains attached to the glass. By means of the two-way stopcock previously mentioned it is possible to

* This cement is similar to sealing wax, but is better for joining metals to glass. It is manufactured by the Central Scientific Company of Chicago.

* In a few instances it has been found that the tubing leaked no matter how well the end seal was made. This is due to imperfections in some pieces of gold tubing.

transfer this radon to the glass capillary and collect it. We prefer to leave it in the apparatus until the following day, when it is collected with the supply for that day. Incidentally the fact that this can be done shows how well the gold tubing is sealed by the action of the cutting pliers. We may mention here another point which saves labor. It is not necessary to seal on a new glass tube with the new gold capillary every time that gold implants are to be made. By heating the DeKhotinsky seal, the short piece of gold tubing remaining from the previous collection can be pulled out and a new one sealed in its place.

III. DOSAGE DATA

Comparison of Radiation. The filtration experiments already mentioned[10] show that for complete absorption of the beta rays a thickness of 0.5 mm. of gold or platinum is necessary. If this wall thickness were to be used for the radon implants, their external diameter would have to be over one millimeter. The trocar required for their insertion into a tumor would then be quite large. It is desirable, therefore, to examine the radiation transmitted by different thicknesses of gold, to see what might be expected from the use of smaller tubes. The experimental apparatus embodied a powerful electromagnet, in order to deflect the beta rays, and thus effect a complete separation of the two types of radiation. The results for different thicknesses of pure gold (or platinum) are given in Table I.

TABLE I

Thickness of Gold, Mm.	Percentage Beta Radiation	Percentage Gamma Radiation
0	100.0	100.0
0.02	27.1	95.0
0.05	8.50	88.7
0.06	6.17	87.7
0.08	4.21	86.6
0.10	2.90	86.0
0.15	1.40	84.6
0.20	0.83	83.4
0.30	0.36	82.0
0.40	0.13	80.7
0.50	0	79.5

From these it will be seen that a very small thickness of gold is sufficient to remove most of the beta radiation. A filter of 0.05 mm. thickness absorbs over 90 per cent, and one 0.2 mm. thick more than 99 per cent. It should be noted also that the gamma radiation is considerably reduced by filters up to 0.05 mm., while additional filtration has little effect. This shows that thin gold filters remove most of the beta radiation and most of the very soft gamma radiation, but do not reduce substantially the hard gamma rays.

From the above results one would conclude that a wall thickness of from 0.15 to 0.20 mm. should be satisfactory for gold implants. Considering, however, the fact that the gamma radiation forms only a small part of the total radiation emitted by the glass tube, a very small percentage of the *total* beta radiation may still be a fairly large proportion of the *transmitted* radiation. Furthermore, it is important to know the absorption of the transmitted radiation by tissue, and particularly the absorption of the beta and gamma ray components separately. For this reason, additional experiments were made, the results of which are given in Table II. Now we can compare the radiation emitted by a glass tube and gold tubes of 0.2 mm., 0.3 mm. and 0.5 mm. wall, after passing through different thicknesses of tissue.

It will be seen first that a gold filter of 0.2 mm. transmits only 3.72 of the total radiation emitted by the glass tube. The filtered radiation consists of 22.5 per cent beta and 77.5 per cent gamma rays. Therefore, while this filter absorbs 99.2 per cent (see Table I) of the *total beta* radiation, the amount transmitted is a substantial part (22.5 per cent) of the total radiation which passes through. In the case of a filter of 0.3 mm., the total radiation transmitted is 3.16 per cent, and of this, 8.8 per cent is beta and 91.2 per cent is gamma radiation. If we compare the radiation which in addition has traversed 5 mm. of tissue, we find that the percentages are 5.43, 2.99, 2.88, and 2.70 respectively for 0, 0.2, 0.3, and 0.5 mm. gold filters. The corresponding values for 10 mm. of tissue are 3.14, 2.80, 2.73, and 2.62. These figures show that the amount of radiation after passing through 5 to 10 mm. of tissue is not very different for the gold and glass tubes. It follows then,

TABLE II

ABSORPTION OF RADIATION BY TISSUE—GLASS AND GOLD TUBES COMPARED

Thickness of Tissue, Mm.	A	B	C	D	E	F	G	H	I	J
	Glass Tube about 0.15 Mm. Wall			Gold Tube 0.2 Mm. Wall			Gold Tube 0.3 Mm. Wall			Gold Tube 0.5 Mm. Wall
	Per Cent of Total Radiation	Per Cent Beta Radiation	Per Cent Gamma Radiation	Per Cent of Total Radiation	Per Cent Beta Radiation	Per Cent Gamma Radiation	Per Cent of Total Radiation	Per Cent Beta Radiation	Per Cent Gamma Radiation	Per Cent of Total Radiation (All Gamma for this Filter)
0	100.00	96.5	3.5	3.72	22.5	77.5	3.16	8.8	91.2	2.77
1	26.35	87.5	12.5	3.50	16.8	83.2	3.06	6.3	93.7	2.76
2	17.00	75.6	24.4	3.35	13.7	86.3	2.98	3.7	96.3	2.74
3	9.67	67.5	32.5	3.20	10.0	90.0	2.93	3.0	97.0	2.73
4	7.00	52.5	47.5	3.09	7.0	93.0	2.88	1.7	98.3	2.71
5	5.43	43.0	57.0	2.99	4.5	95.5	2.84	1.0	99.0	2.70
7	3.90	24.3	75.7	2.88	1.5	98.5	2.79	0.5	99.5	2.67
10	3.14	....	100.0	2.80	....	100.0	2.73	...	100.0	2.62
15	2.87	....	100.0	2.68	....	100.0	2.62	...	100.0	2.54

that in the case of the glass tube, the intervening tissue must have absorbed a much greater amount of radiation. The glass tube radiation which has traversed 5 mm. of tissue, consists of 43 per cent beta and 57 per cent gamma, showing that a considerable amount of beta radiation is still present.

At this point it may be well to say a few words about the measurement of the "quantity" of radiation. In Table II we give the relative amounts of beta and gamma radiation emitted by the glass tube as 96.5 and 3.5 respectively. That is, the beta radiation is many times *larger* than the gamma. The values given by Rutherford,[11] however, are in the ratio of 3.2 to 4.7, indicating that the beta radiation is somewhat *less* than the gamma radiation. The large discrepancy between these two sets of values is due to the difference in the definition of *quantity* of radiation, Rutherford's values refer to the amount of energy emitted as beta or gamma radiation. The values given in Table II were obtained by ionization measurements with an air chamber 50 cm. long. The readings depend, therefore, on the amount of radiation absorbed by this volume of air (plus the effect of secondary rays, etc). For this reason the beta radiation produces relatively a much larger effect. This is also true in the case of a biological effect produced by radiation. Hence, while the values of Table II do not represent the relative *intensities* of the two types of radiation, they represent the biological effectiveness of the rays *more closely* than would the true intensities.

It is sometimes claimed that the bare tube method of treatment enables us to utilize practically all of the beta radiation emitted by the radon tubes. The data we have already presented, however, do not bear out this contention, but, on the contrary, show that most of the beta radiation is worse than useless. To appreciate this point, we must remember that in practice the bare tubes are not placed very close together in a tumor. The usual spacing aimed at is one centimeter, but, on account of practical difficulties, some may be considerably farther apart. This means that the amount of radon in each tube must be large enough for the radiation to be effective at a distance of 5 mm. or more. The radiation which is capable of passing through 5 mm. of tissue is only 5.43 per cent of the total emitted by the bare tube. Of this amount, 43 per cent, that is (5.43 $\times$ 0.43 =) 2.34 per cent of the total is radiation. Over 90 per cent of the total beta radiation emitted, therefore, is absorbed by 5 mm. of tissue, and is not available at a greater distance from the source. Now the radiation which produces the desired tissue effect at a distance of 5 mm. is necessarily more intense at a

shorter distance, and, therefore, it is *more than sufficient* to produce the same effect in the intervening tissue (0 to 5 mm.). The additional beta radiation which is absorbed in this region is not only superfluous, but objectionable, because it increases the amount of necrosis.

Since the radon implants are very small they can be assumed to be "point" sources for the approximate calculation of the intensity of radiation at different distances. On the other hand, the figures of Table II can be used to determine the effect of gold and tissue filtration. Combining the inverse square law and the absorption effect, we can estimate roughly the intensity of radiation delivered to different points in the tissue by radon implants of various degrees of filtration. The results thus calculated are shown graphically in Figure 2. The very rapid decrease of the intensity of radiation as we move away from the source can be seen at a glance. It should be noted particularly that the decrease is very rapid not only from the bare tube but for the gold filtered implants as well. Accordingly, *in any case*, the dose of radiation received by the tissue in the neighborhood of the source is very much greater than that delivered to points at greater distances. However, at the same distance from the source, more radiation is delivered by the bare tubes than by the filtered tubes of the same radon content. The difference becomes less marked the greater the distance from the source, and at 10 mm. it is practically negligible. The relative position of the curves is also of interest. Those for the three gold filters are grouped closely together, indicating that little is gained by using a thickness of gold greater than 0.2 mm.*

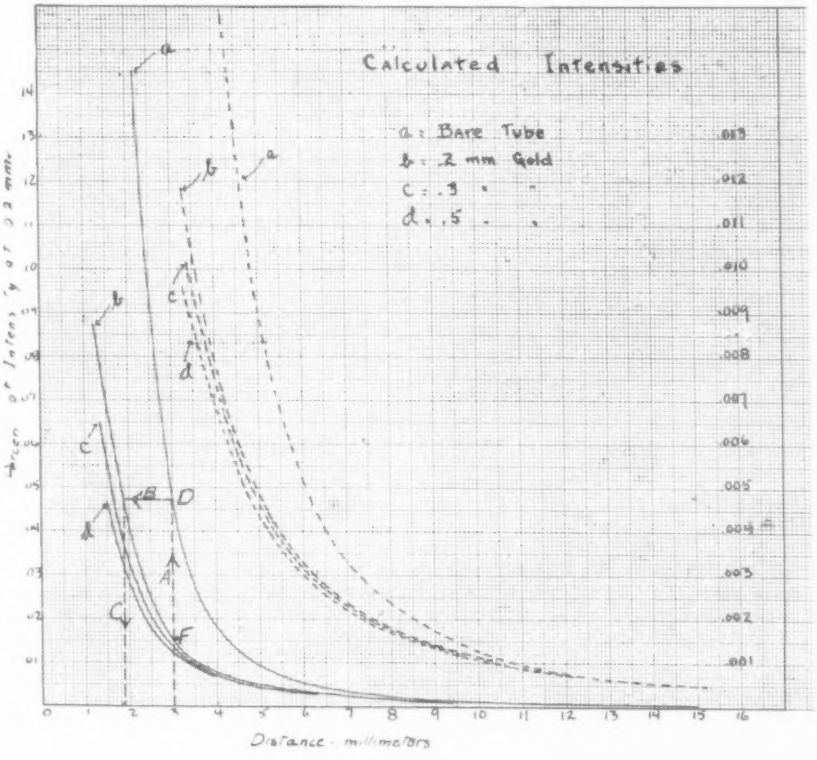

Fig. 2.

By means of the curves of Figure 2, we can get an idea of the tissue effect to be expected from the use of glass or gold implants. Let us assume that a bare tube of one millicurie initial value inserted permanently into a definite type of living

* This point will be discussed again later.

tissue produces a region of necrosis 3 mm. in radius. Then, following the lines ABC in Figure 2, we find that the radius of necrosis for a gold tube having a wall thickness of 0.2 mm. and the same radon content as the glass tube (1 mc.) should be 1.88 mm. Or, looking at the question from a different point of view, in order to produce the same amount of necrosis with the 0.2 mm. gold tube as with the glass tube, the former should contain $\frac{0.049}{0.014} =$ 3.5 millicuries of radon (the intensities at D and F (Fig. 2) being 0.049 and 0.014, respectively).

In the above determinations we have assumed tacitly that "equal" quantities of radiation produce the same biological effect whether a glass or a gold tube is used as the source. Since, however, the quality of the radiation emitted by the two is quite different, even after it has traversed 3 mm. of tissue, and equality of quantity determined from the curves of Figure 2 refers to equal ionization effects, the assumption is not justified. The above results, therefore, should be considered only as first approximations. In order to make a true comparison of the effects produced in living tissue, animal experiments should be carried out, maintaining all conditions the same, as nearly as possible, and using statistical methods to interpret the results.

COMPARISON OF EFFECTS

1. *Butter Experiments.* Since animal experiments require a great deal of time, we decided to obtain additional comparative information by a simple method which had been previously developed in our laboratory.[12] It has been found by Sugiura that radium radiations bleach ordinary table butter. When a tube containing a sufficient amount of radon is placed on the smooth surface of a block of butter (which is kept on ice) one can observe an area of discoloration which increases in size for a number of days. The outline of this region is quite sharp and can be measured with fair precision. The physical conditions which determine the distribution of the radiation around the tube are quite comparable when butter and tissue are used as the media. Accordingly some definite information can be obtained by measuring the area of discoloration around tubes of different strengths, and different filtration.

The results of such experiments with butter medium and gold tubes of 0.2 mm. wall thickness are shown graphically in Figure. 3. It will be seen that the radius of the discolored region increases rapidly during the first few days and then approaches gradually a maximum value depending on the initial radon content of the tube. This is due chiefly to the fact that the radon disintegrates quite rapidly, dropping to one-half of the initial value in 3.85 days. It is interesting to note that after the eighth day the curves tend to become parallel. The relative spacing, therefore, remains nearly the same from this time on. Accordingly there must be a proportional increase in the radii from day to day. This is shown in Table III, where the percentage variation in the radii, for the millicurie values used, is given for different days. Since the percentages in each column agree closely, average values were taken to represent

TABLE III

BUTTER EXPERIMENTS. 0.2 MM. GOLD. PERCENTAGE RATIOS OF DIAMETERS OF DISCOLORATION, 8TH TO 18TH DAY

Radon, Mc.	8th Day		10th Day		12th Day		15th Day		18th Day		Average Per Cent
	Diam.	Per Cent	Diam.	Per Cent	Diam.	Per Cent	Diam.	Per Cent	Diam.	Per Cent	
1.38	4.75	100.0	5.02	100.0	5.20	100.0	5.30	100.0	5.38	100.0	100.0
1.75	5.30	111.5	5.62	111.8	5.83	112.0	6.00	113.1	6.06	112.5	112.2
2.68	6.96	146.5	7.28	145.0	7.53	144.6	7.80	147.0	7.97	148.0	146.0
4.44	7.70	162.0	8.19	163.0	8.52	163.6	8.87	167.2	9.08	168.5	165.0
7.31	9.10	191.5	9.61	191.2	10.00	192.0	10.35	195.4	10.60	197.0	193.4
11.07	10.4	233.0	10.99	219.0	11.40	219.2	11.75	222.0	11.98	223.0	223.2

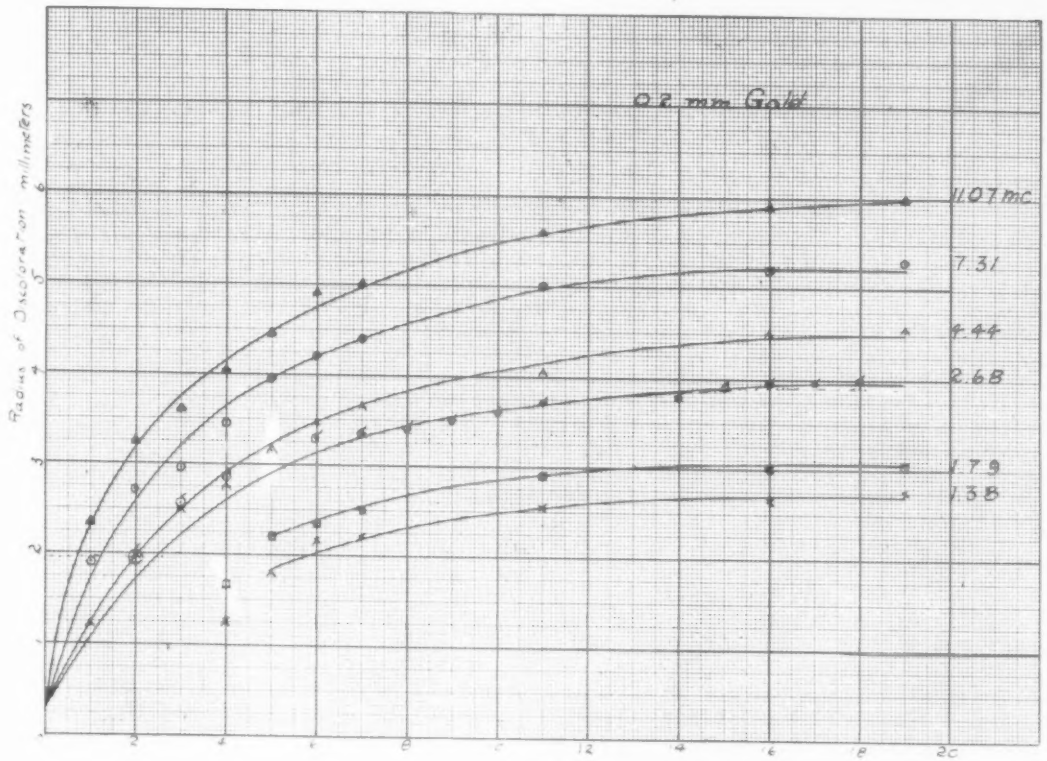
0.2 mm Gold
Radius of Necrosis in millimeters
11.07 mc
7.31
4.44
2.68
1.79
1.35

FIG. 3.

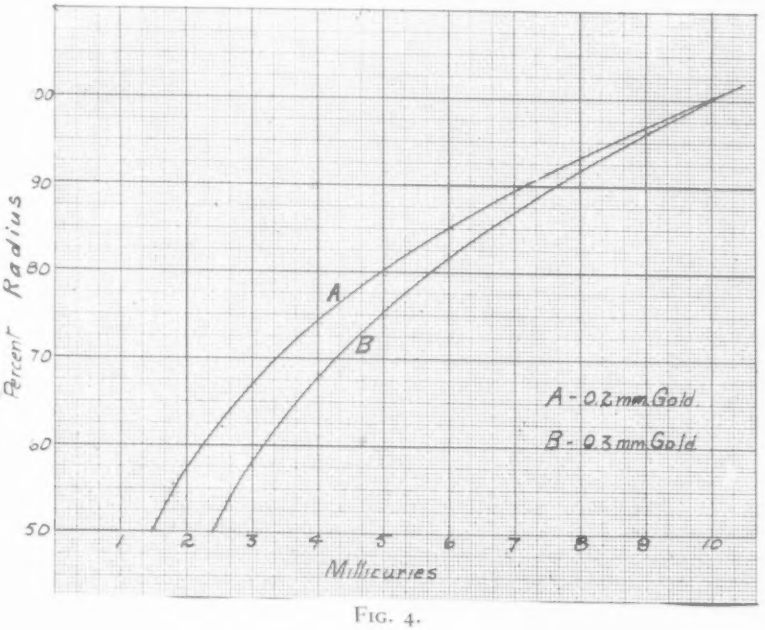
Percent Radius
Millicuries
A
B
A - 0.2 mm Gold
B - 0.3 mm Gold

FIG. 4.

the relative radii of discoloration at any time between the eighth and the eighteenth days, for the tubes used in the experiment. They are given in the last column of Table III. The relation between the initial millicurie value and the percentage variation in the radius is shown in Curve A of Figure 4, in which the value for 10 mc. is taken as 100 per cent.

In another experiment of this type, gold tubes of 0.3 mm. wall thickness were used, and similar results were obtained. Curve B of Figure 4 was derived from these results, and is comparable to Curve A. The fact that these two curves do not coincide shows that the area of discoloration increases at a different rate with respect to the millicurie value of the tube, for the 0.2 and 0.3 mm. gold filters. This is as might be expected considering that the quality and quantity of the radiation passing through the two filters is different.

In order to make a direct comparison of the areas of discoloration for 0.2 and 0.3 mm. gold filters, we have plotted in Figure 5 the values on the eighteenth day, for tubes of different radon content. It will be seen that, for any millicurie value, the radii are quite different for the two filters. Thus for a 2 mc. tube they are 3.4 mm. and 2.25 mm., according to whether the filter is 0.2 or 0.3 mm. gold.

It is instructive also to compare glass and gold tubes as regards the area of discoloration they produce. For this purpose we used a glass and a gold tube of 0.2 mm. wall thickness, both of the same length, and each containing 2.55 mc. of radon. The radii of the discolored areas on different days are given by Curves A and B, Figure 6. Curve C, for a 0.3 mm. gold tube of the same strength, was not determined experimentally, but the data of Figure 5 were used to locate its position. The radii and relative values of discolored butter are given in Table IV. It will be noted that filtration by a small thickness of gold reduces markedly the amount of butter which is discolored by the radiation from a given quantity of radon. There is

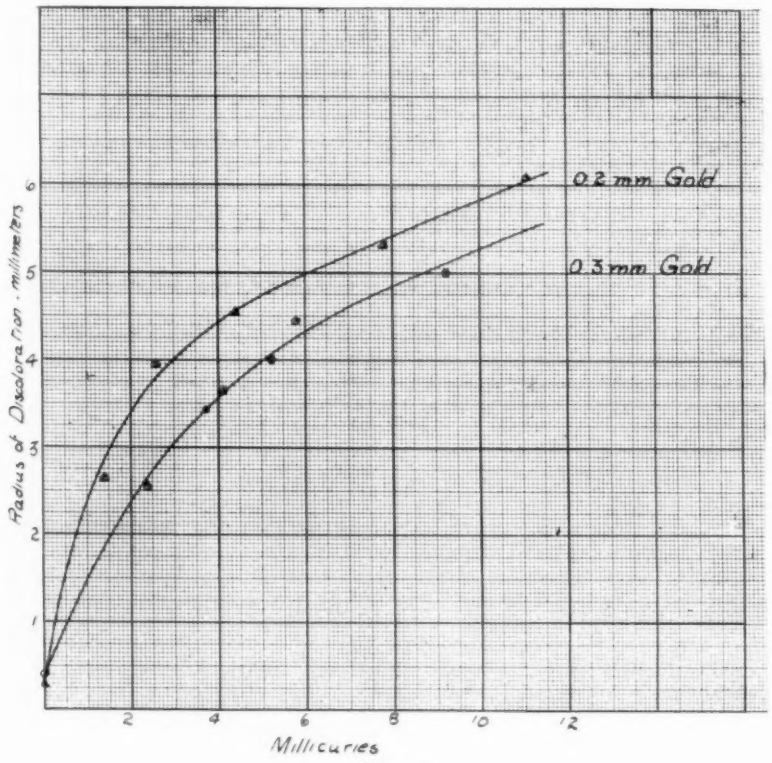

FIG. 5.

considerable difference also between 0.2 and 0.3 mm. gold filters.

TABLE IV
BUTTER EXPERIMENTS—EIGHTEENTH DAY
Tubes 5–6 mm. long, containing 2.55 mc.

Filter		Relative	
Material	Millimeters	Radius	Volume
Glass	0.15	100.0	100.0
Gold	0.2	61.7	23.5
Gold	0.3	45.5	9.4

volumes of butter which would be affected by tubes of different filtration, on the basis of the ionization experiments from which the curves were obtained. It is hardly necessary to describe how this can be done, and therefore we shall simply give the results in Table v.

Comparing Table IV and V we find that the values for the gold filters estimated from the ionization curve are much larger than those obtained experimentally. It should be remembered, however, that in

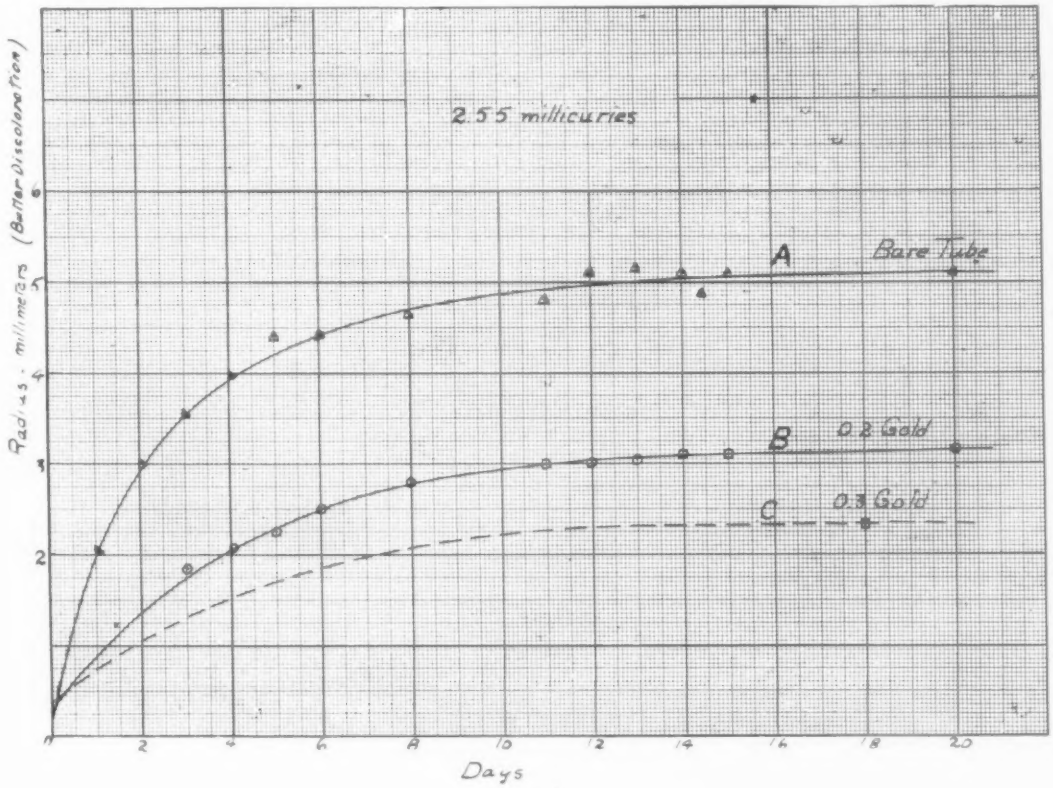

FIG. 6.

TABLE V
IONIZATION EXPERIMENTS

Filter		Estimated Relative	
Material	Millimeters	Radius	Volume
Glass	0.15	100	100
Gold	0.2	76	44
Gold	0.3	73	39

Referring back to the curves of Figure 2 now, we shall estimate the relative

calculating the radiation intensities in the absorbing medium (tissue) at different distances from the source, we assumed a point source, and neglected the scattered radiation. Furthermore, when we predicted the radii of discoloration (Table V) we assumed that the same quantity of radiation would produce the same effect, irrespective of quality. If account had been taken of the scattered radiation, the discrepancy between the two sets of values would probably have been even greater.

Accordingly the results point to the conclusion that the beta radiation is more effective in discoloring butter than it is in ionizing the air in the chamber used for the experiments. One might reasonably suppose that the beta radiation is also more effective in producing changes in living tissue, and that, therefore, the butter experiments give a good indication of the differences which may be expected in the tissue effects for glass and gold tubes well. The actual experimental procedure, and the detailed observations made, are described by Cutler in this issue of the Journal. We may say here briefly that tubes of different radon content were inserted into the dorsal muscle of a rabbit and were allowed to remain *in situ* until the animal was sacrificed. After a muscle had been excised, the tube in it could be located accurately by transmitted light. A section was then made as nearly as possible perpendicular to the

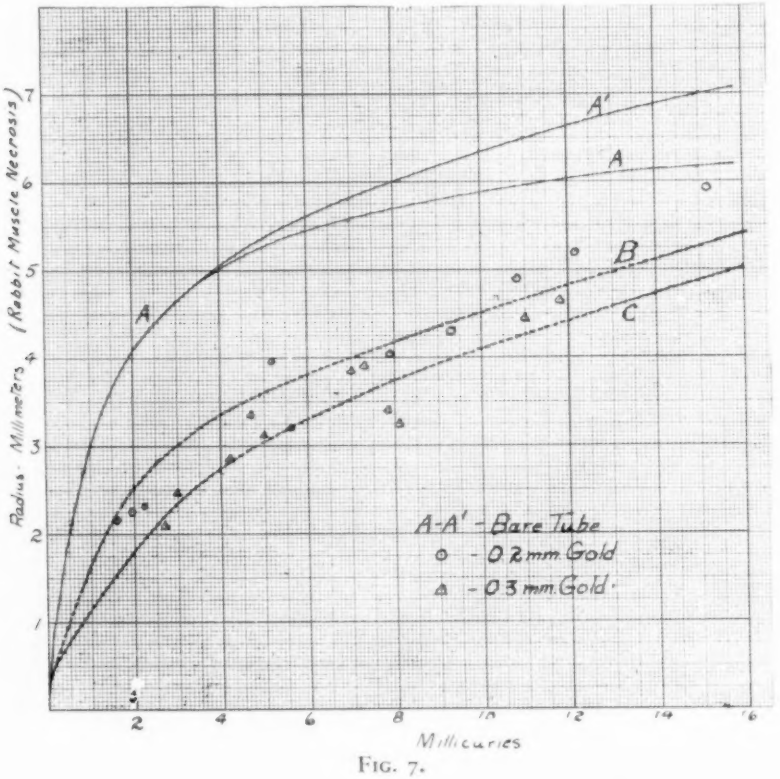

FIG. 7.

of various degrees of filtration. This point is discussed further in another publication from this laboratory.[13]

2. *Rabbit Experiments.* In the use of bare tubes for therapeutic purposes, one of the most important things is the quantitative relation between the strength of the tube and the volume of necrosis produced. For this purpose a long series of experiments was carried out in our laboratory,[12] using the dorsal muscle of the rabbit as the test tissue. After having developed the technique of collecting radon in gold tubes the work was extended to include gold implants as tube at its center, and the affected area was measured carefully.

The number of tissue experiments made with gold tubes is too small to permit us to determine accurately the quantitative relation between the amount of radon and the volume of complete and partial necrosis produced in rabbit muscle. The significant data from this work are recorded in Figure 7, in which the circles refer to 0.2 mm. and the triangles to 0.3 mm. gold filters. The radii given are for the area of necrosis, whether complete or partial. The dimensions of the zone of hyperemia do not

appear here. Curves A and A′ are taken from our previous work with glass tubes[12], allowance having been made for the different lengths (12 mm. instead of 6 mm.) of the tubes used in those experiments. In this case Curve A refers to the area of necrosis and Curve A′ to the outer limit of the zone of congestion or hyperemia observed in the fresh tissue. In spite of the irregular distribution of the points for gold tubes, we may draw some fairly definite conclusions.

It will be seen that for gold tubes containing from 0 to 15 mc. of radon, the radius of the necrotic area produced in rabbit muscle is always smaller than for the glass tube of corresponding strength. The difference is more marked for the weaker than for the stronger tubes. The trend of the points given on the chart indicates that for stronger tubes than were used in the experiments, the area of necrosis would be nearly the same, whether a filter was used or not. This is as one might expect, on account of the fact that after passage through a sufficient amount of tissue the radiation from the glass and gold tubes becomes nearly the same. There is considerable overlapping of the points for the 0.2 and 0.3 mm. gold tubes. Nevertheless, it is clear that, in general the radius of necrosis for a 0.3 mm. tube is smaller than for a 0.2 mm. tube, of the same strength.

It will be remembered that the butter experiments showed a considerable difference between the areas of discoloration produced by equal gold tubes of 0.2 and 0.3 mm. wall thickness. Radon tubes of the same length, filtration, and millicurie value, produce an area of discoloration in butter which is appreciably larger than the area of necrosis produced in rabbit muscle. A direct comparison between the results of the two different experiments, therefore, cannot be made. On the other hand, the rabbit experiments are too few to permit us to draw average curves through the points for 0.2 and 0.3 mm. gold tubes. However, additional information may be obtained by the following procedure: The curves of Figure 4 give the *percentage* variation of the radius of discoloration with respect to the strength of the tube, for 0.2 and 0.3 mm. gold. Accordingly, if we assign a definite value to the radius for a given radon content of the tube, we can calculate what the radius would be for other millicurie values. Inspection of Figure 7 shows that the probable radius of necrosis produced by a 0.2 mm. gold tube of 10 mc. is 4.5 mm. Taking this value also for the radius of butter discoloration which would be produced by the same tube, we determine the radii for tubes of different radon content, making use of Curve A, Figure 4. The results are given by Curve B, Figure 7. By a similar process Curve C is obtained for the 0.3 mm. gold filter. In this case the value of the radius for a 10 mc. tube was taken as 4.06 mm. to bring the two curves (B and C) in the same relative position as they are in Figure 5.

In view of the variations apt to occur in the rabbit experiments it will be seen that the two curves B and C might be considered to fit quite well the points experimentally determined. The greatest discrepancy between the observed and the calculated radii is 11 per cent. This refers to the point for 15.2 mc. and 0.2 mm. gold. It is very probable that the observed radius of necrosis is too large, and that the average radius for a number of experimental determinations for this point would fall very close to the curve. In this connection we may point out that the gold tube curves could not possibly cross the bare tube curves because this would mean that the filtered implants produce more necrosis than the bare tubes. Accordingly the curves must be asymptotic—coming gradually together. At any rate, in the absence of more extensive tissue experiments, we may take these two curves to represent the variation of the radius of necrosis with respect to the millicurie value of the tube for 0.2 and 0.3 mm. gold tubes, respectively. They will enable us to make first approximations as to the millicurie dose required when gold tubes are used instead of bare tubes.

Utilization of Results. We have discussed the question of dosage for the case of the bare tubes in the paper already referred to. Therefore we shall mention here only those points which have a bearing on the present problem. At the Memorial Hospital experience has shown that bare

tubes of 1 mc. each, properly distributed throughout the tumor mass, give very satisfactory final results. From some tests we have made in collaboration with Dr. Douglas Quick we find that the spacing of the tubes in tumors of different shapes and sizes should not be the same. We may say, however, that the distance between adjacent tubes of 1 mc. each varies from 7 to 12 mm. according to the shape and size of the tumor.*

Let us take now a small tumor (Fig. 8) which can be made to disappear by the use of 2 bare tubes (A and B) of 1 mc. each,

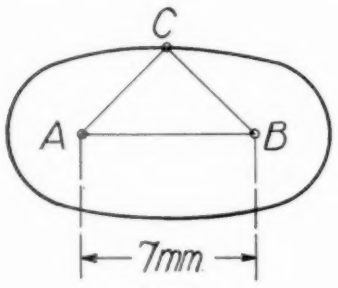

FIG. 8.

placed 7 mm. apart. If the tumor disappears it means that the radiation was effective at every point within the obviously involved region, and probably a little beyond. For instance, the dose must have been effective at the point C. Since the distance AC or BC in Figure 8 is 5 mm., it follows that each tube delivered one-half of the necessary dose at this distance. If we wish to use gold tubes of 0.2 mm. wall thickness instead of bare tubes, we must determine the radon content which should be used in order to get the same dose at the point C, that is, at a distance of 5 mm. from the center of the tube.

Equality of dose in this case means that the radiation from the bare tubes and the gold tubes produces the same effect on the tumor cells at C. We have no quantitative information regarding the effect on tumor tissue produced by the radiation from glass and gold tubes. However, the rabbit experiments enable us to determine the doses which produce equal effects in the rabbit muscle. Thus for a bare tube, the millicurie dose which is just sufficient to produce necrosis at a distance of 5 mm. is 4 mc. (Fig. 7), and for a 0.2 mm. gold tube it is 13.2 mc. If the bare tube contains 1 mc., the dose at a distance of 5 mm. is then $\frac{1}{4}$ of the necrosis dose! of the experiments. Therefore the same dose will be delivered at a distance of 5 mm. by a 0.2 mm. gold tube if the radon content is $\frac{13.2}{4} = 3.3$ mc. Accordingly in treating the tumor of Figure 8 with 0.2 mm. gold tubes they should contain 3.3 mc. each if the dose is to be the same as when two bare tubes of 1 mc. each are used.

It is instructive now to compare the doses of radiation at different distances from a bare tube of 1 mc. and a 0.2 mm. gold tube of 3.3. mc. These can be calculated from the curves of Figure 7 in the following manner: The curves were determined by using borderline tissue necrosis as the biological indicator. Therefore the radiation dose at the periphery of the necrotic region represents the dose necessary and sufficient to produce rabbit muscle necrosis, under different conditions of filtration and distance. Taking this as a unit, it will be seen that the dose delivered to different points in the tissue by a given tube, is inversely proportional to the millicurie value of the tube which will produce borderline necrosis at the point in question. For instance, let us consider a 0.2 mm. gold tube containing 10 mc. of radon. From Curve B we see that this will produce necrosis up to a distance of 4.5 mm. At shorter distances, therefore, the dose delivered by this tube is more than sufficient to produce necrosis. At a distance of 3 mm., for example, necrosis can be obtained by using a similar tube of 2.8 mc. Hence the given tube of 10 mc. will deliver $\left(\frac{10}{2.8} = \right) 3.6$ times the dose required to produce necrosis at this distance. Similarly, at a distance of 5 mm. the 10 mc. gold tube will deliver $\left(\frac{10}{13.2} = \right)$ 0.76 of the muscle necrosis dose. The doses for a 1 mc. bare tube and a gold tube of 0.2 mm. wall, containing 3.3. mc. of radon, calcu-

* The radiosensitivity of the tumor, of course, plays an important part in the dosage. We refer here particularly to epidermoid carcinoma occurring around the mouth.

lated in this manner, are given in Table VI. For convenience the dose at a distance of 5 mm., being the same in both cases, is taken as 100 arbitrary units.

TABLE VI

Distance, Millimeters	Bare Tube, 1 Mc.	0.2 Mm. Gold Tube, 3.3 Mc.
2	800	940
3	400	440
4	200	190
5	100	100
6	31	63

It will be seen that for distances less than 5 mm., the doses are very nearly the same for both tubes. For distances greater than 5 mm., the dose delivered by the gold tube is much larger. Unfortunately the curves of Figure 7 do not permit us to go beyond 6 mm., and even for this point there is considerable uncertainty due to the extrapolation. It is evident, however, that the gamma radiation being only slightly reduced by the gold filter, the dose delivered at a distance of 8 or 10 mm. by the gold tube of 3.3 mc. must be about three times as large as the dose delivered there by a 1 mc. bare tube. In regard to the doses at distances smaller than 5 mm., they are about the same for the tubes here considered, *only apparently*. This is due to the fact that in getting the curves of Figure 7 we did not differentiate between complete and partial necrosis.* The radii there given are for areas of necrosis, whether complete or partial, but in the case of the gold tubes a large part of the area measured consists of partial necrosis. In this region, therefore, the dose must have been considerably lower than in the corresponding region for the bare tube, where complete necrosis was produced. This is particularly true for relatively weak tubes. We may say, then, that a bare tube of 1 mc. and a 0.2 mm. gold tube of 3.3 mc. produce substantially the same amount of necrosis (3 mm. radius according to Fig. 7), but while for the bare tube the necrosis is complete, practically throughout the region, for the gold tube it is largely incomplete. What difference this makes in the treatment of patients can be determined only clinically. This is beyond the province of the present paper, but we shall say something about it later. For the present we wish to point out that we have made a comparison of doses on this basis in order to be on the safe side.

We have seen how the use of two 0.2 mm. gold tubes of 3.3 mc. each, in the treatment of the tumor of Figure 8 gives the same dose at the point C as with two bare tubes of 1 mc. each. The necrosis produced in the two instances, whether partial or complete, will be the same, but the dose beyond the tumor outline will be much larger in the case of the gold tube treatment. This point is of considerable practical importance. In the first place, it is difficult to determine the exact extent of the tumor, and there is always a possibility that tumor cells may be present beyond the obviously involved region. Then it is also difficult to make sure that the tubes are properly spaced within the mass that one decides to treat. On account of these practical difficulties, some tumor cells may be at a greater distance from the tubes implanted than one would suppose them to be. If bare tubes are used, the action is practically localized around each source, and these cells may not receive a sufficient dose. On the other hand, with gold tubes the distribution of radiation is much more uniform and small differences in distance do not affect the dosage very much.

We have determined the millicurie value of a 0.2 mm. gold tube which will give the same dose at a distance of 5 mm. as a 1 mc. bare tube. This was based on the assumption that the two tubes would be placed in the tumor 7 mm. apart (Fig. 8). If a different spacing is used the strength of the gold tubes should be varied also. In Table VII we give the millicurie values for gold tubes of 0.2 and 0.3 mm. wall thickness according to the spacing. They are calculated in the manner outlined above to give the same dose at the point C, analogous to that in Figure 8, when bare tubes of 1 mc. each are placed 7, 8, 9, etc., mm. apart. It will be seen that the values decrease as the distance increases. The curves of Figure 7 cannot be extrapolated sufficiently to

* This important distinction is brought out fully by Cutler (loc. cit.).

give definite values for spacings larger than 8 mm. It is evident, however, that the values are less than 2 mc., and in the table we have added the minus sign to indicate this fact. That there should be a decrease in the millicurie value is obvious when we consider that the radiation, after passing through a sufficient thickness of tissue is nearly identical for a glass or a gold tube of equal strength.

TABLE VII

Value of Bare Tube, 1 Mc.

Distance between Parallel Tubes, Millimeters	Millicurie Values for Gold Tubes	
	0.2 Mm.	0.3 Mm.
7	3.3	3.9
8	2.4	2.7
9	2—	2—
10	2—	2—

In general the spacing employed in practice with 1 mc. bare tubes is about 10 mm. In reality this is the spacing aimed at, but due to practical difficulties, it is certain that in a fairly large tumor some adjacent tubes are more than 10 mm. apart. If there is a local recurrence one may assume that either the spacing or the total dose was incorrect. When gold tubes are used the spacing is not so important as in the case of the bare tubes, and the final result depends more on the total dose administered. This simplifies the process of determining, by clinical experience, what the proper dosage is.

Those who have had considerable experience in the use of bare tubes have arrived at certain doses which they know are generally effective in treating certain tumors. It is certain that these doses are considerably larger than would be required if one could always be sure that the tubes were properly distributed throughout the tumor mass. It is the opinion of the writer, therefore, that in the ultimate analysis, the gamma radiation is what one must rely on, especially in fairly large tumors. Accordingly the bare tube doses which have been found to be successful are such as will give enough gamma radiation throughout the involved region to cause a complete disappearance of the tumor. The soft beta rays serve no useful purpose, and the hard rays contribute little to the dose at critical points in the tumor. In view of these considerations we may conclude that in using gold tubes the millicurie dose need not be much larger than the dose one would use with bare tubes. Furthermore, according to the results of Table VII and Figure 7, if the spacing between adjacent tubes is about 10 mm., a gold tube of approximately 1.5 mc. is more effective at the critical point C (Fig. 8) than a 1 mc. bare tube. Hence the substitution of 1.5 mc. gold tubes for the same number of 1 mc. bare tubes should result in at least an equally effective treatment. It is probable, however, that the fear of producing too much necrosis with bare tubes may lead the radiologist to decide on a smaller dose than is really required. To be on the safe side, therefore, we recommend that in the beginning at least, the substitution of gold tubes for bare tubes be made on the basis of one 2 mc. gold tube of 0.2 mm. wall thickness for each 1 mc. bare tube, other conditions remaining the same. If this is done the dose will be more effective than with the corresponding bare tube treatment, and still the amount of necrosis will be much less.

In order to bring out this point more clearly we give in Table VIII the radii of necrosis produced in rabbit muscle by tubes of different filtration, containing from 0.5 to 10 mc. of radon. Assuming that the region of necrosis is spherical (which is essentially true in the case of short implants), we can calculate the volume of necrosis. For purposes of comparison it is

TABLE VIII

Radon Content, Mc.	Necrosis (Complete and Partial)					
	Glass Tube		0.2 Mm. Gold Tube		0.3 Mm. Gold Tube	
	Radius, Mm.	Volume, Per Cent	Radius, Mm.	Volume, Per Cent	Radius, Mm.	Volume, Per Cent
0.5	2.0	30	1.0	3.7	0.8	1.9
1.0	3.0	100	1.6	14.8	1.14	5.5
1.5	3.6	174	2.1	34.5	1.5	12.6
2.0	4.1	255	2.5	57.8	1.8	21.5
2.5	4.4	315	2.8	81.5	2.1	34.5
3.0	4.6	360	3.0	100.0	2.3	45.0
4.0	5.0	460	3.4	146.0	2.7	73.0
5.0	5.3	550	3.6	173.0	3.1	110.0
7.0	5.6	650	4.0	237.0	3.5	163.0
10.0	5.9	760	4.5	340.0	4.1	253.0

preferable to express this in percentage of the volume of necrosis produced by a one millicurie bare tube. In so doing we reduce considerably the error introduced by assuming the necrotic region to be spherical. The relative volumes of necrosis are given in Table VIII also. It is evident that very much less necrosis is produced by filtered than by unfiltered implants of the same millicurie value.

A comparison of the values for 0.2 and 0.3 mm. gold tubes shows that the larger filtration is considerably more effective in reducing the amount of tissue necrosis. From this point of view, therefore, gold implants with a 0.3 mm. wall thickness are preferable. However, the outside diameter of the tubes, of necessity, will be increased from 0.55 to 0.75 mm. We feel that tubes of this diameter and about 5 mm. long are not too large for interstitial use. So far these have been used at the Memorial Hospital for experimental work only, but we expect to use them regularly in place of the 0.2 mm. tubes. The additional filtration has little effect on the gamma radiation, so that the radon content of the implants need not be increased substantially in order to administer the same dose to a tumor. In this case also 2 mc. per implant is probably a suitable amount.

Necrosis could be eliminated almost entirely by the use of a thicker gold filter and a thin secondary filter of light material. This would entail a further increase in the diameter of the container, and it is problematical whether such implants should be left permanently in the tissue. However, it is a relatively simple matter to prepare removable gold implants. This complicates the therapeutic procedure very considerably, and probably is not desirable as a general measure. Nevertheless, such a method is employed very extensively at the Paris Radium Institute, and therefore we wish to point out that by collecting the radon directly in a gold tube as described in this paper, smaller implants are available for the purpose.

The comparison of the volumes of necrosis given in Table VIII is not complete without giving some weight to the difference in the *quality* of the necrosis produced by glass and gold tubes. As previously mentioned, the zone of complete necrosis in the case of filtered tubes is distinctly smaller than the total area measured, which includes also the zone of partial necrosis. In the case of the glass tubes practically the whole region consists of complete necrosis. What significance this has in the treatment of patients is a matter for clinical study. Gold implants have been used extensively in the clinical departments of the hospital for over a year and detailed reports of the work will soon be available. We may say here, however, that gold implants produce much less sloughing and cause much less discomfort than bare tubes. No glass implants have been used at the hospital since January, 1926.

SUMMARY AND CONCLUSIONS

In this paper we present a method for the collection of radon in fine gold tubes of 0.15 mm. internal diameter. The method is such that practically no complications are introduced in the routine collection of radon as carried out in hospitals. The additional cost of the gold tubing is insignificant in comparison to the cost of the radon itself.

Using a wall thickness of 0.2 or 0.3 mm., the individual tubes can be made so small that they can be left permanently in a tumor. The trauma caused by the introduction of the tubes into the tissue to be treated is not serious. It is only slightly more than is ordinarily produced by the "bare tube" technique—the needles used to implant the gold tubes being only a little larger in diameter.

We report the results of experiments undertaken for the purpose of determining approximately the dosage which should be used when gold implants are substituted for bare tubes. The work was planned with the idea of getting information from different angles to facilitate the interpretation of the biological findings. The experiments were:

1. Determination of the relative amounts of beta and gamma rays emitted by glass and gold tubes of various wall thicknesses. Study of the absorption of these radiations by tissue. An ionization

instrument and an electromagnet were used for this purpose.

2. Determination of the area of butter discolored by the radiation from glass and gold tubes of various strengths. Tubes of different radon content and filtration were placed on the smooth surface of a butter medium and the diameters of the discolored areas were measured from day to day. In this way we obtained a relation between the initial strength of the tube and the extent of the effect produced in the butter.

3. Determination of the amount of tissue necrosis produced by bare tubes and 0.2 or 0.3 mm. gold tubes containing different amounts of radon. Rabbits were used for this experiment and the tubes were allowed to remain in the dorsal muscles for one or two weeks. The number of such determinations made with gold tubes was not sufficient to give a definite relation between the initial strength of the implant and the radius of the necrotic region. Nevertheless the data obtained therefrom enabled us to draw certain definite conclusions which are useful for dosage purposes. A careful histological study of the tissue round the implants has been made by Cutler, and is reported separately.

A critical analysis of the information available at present leads us to the following conclusions:

1. A gold filter 0.2 mm. thick removes over 99 per cent of the beta radiation emitted by the ordinary glass container (bare tube). Enough passes through, however, to form a substantial percentage (22.5 per cent) of the transmitted radiation. If the filter thickness is 0.3 mm. the proportion of beta radiation is reduced to 8.8 per cent. In conformity with this result, the amount of butter discolored and the amount of necrosis produced in rabbit muscle, are both larger for 0.2 mm. than for 0.3 mm. gold implants, other conditions remaining the same. The external diameter of the 0.3 mm. gold implants is 0.75 mm., which is not too large for intratumoral use. Accordingly 0.3 mm. gold implants are preferable.

2. "Bare tubes" or "seeds" have been used extensively for several years and radiologists have worked out their own dosage for the effective treatment of definite tumors. On the other hand, the extensive therapeutic use of gold implants is too recent to permit the determination of proper dosage from clinical experience alone. For these reasons we decided that our dosage recommendations should be based on the substitution of gold for glass implants. Therefore the radiologist should decide first the number of one millicurie bare tubes and the distribution he would use for a given tumor, and then he should substitute gold tubes of the strength indicated in Table VII according to the spacing. We feel that in general the substitution of 2 mc. gold implants of 0.2 mm. or 0.3 mm. wall thickness, for 1 mc. bare tubes, results in the more effective irradiation of the tumor tissue. The necrosis produced thereby is much less.

3. According to the figures of Table VIII the necrosis produced by 0.2 mm. gold implants containing 2 mc. of radon is 59 per cent of the amount produced by 1 mc. bare tubes. The necrosis is complete in the case of glass tubes, but only partial in the case of gold tubes. This difference in the character of the necrosis probably plays an important part in the observed reaction of the irradiated tissue. Clinical experience at the Memorial Hospital shows that by using gold implants sloughing is generally diminished or completely eliminated and that in general patients have little discomfort from the treatment.

The author wishes to express his indebtedness to his colleagues and assistants, whose enthusiastic spirit of cooperation made this work possible. Special thanks are due to Mr. E. Lobley, who prepared the gold implants; to Mrs. E. H. Quimby, who carried out the ionization experiments; to Dr. K. Sugiura, who made the butter discoloration determinations; and to Dr. M. Cutler and Mr. N. Goldsmith, who carried out the rabbit experiments. The author wishes to thank also the Clinical Staff of the Hospital for the interest shown during the progress of the work, and for the information derived from the treatment of patients.

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NEW RESEARCH IN THE ETIOLOGY OF CANCER, WITH REFERENCE TO THE WORK OF GYE*

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NOWHERE in the medical sciences is there greater interest manifested at the present time than in Gye's new work on the etiology of cancer which was reported in July, 1925. These studies were so iconoclastic that practically every laboratory is busy working along similar lines. Although it is not my intention at the present to evaluate or defend Gye's theories, at any rate it seems worth while to discuss his experimental results, and what bearing they have upon the causation of cancer.

In an attempt to extend the studies upon the filterability of the Rous chicken sarcoma, Gye made use of anaerobic cultivation of tumor tissue, and found that this method could be applied to the study of the filterability of mammalian tumors. The preliminary work of Rous in 1911 first pointed out that a spindle cell sarcoma of the Plymouth Rock fowl could be transmitted to other fowl of the same species by a tumor extract which had been rendered cell free by passage through a Berkefeld filter. His technique at that time consisted in grinding the minced tumor with sand, diluting the mince with saline, and then passing this solution through a filter. The filtered fluid when injected into other birds of the same species would produce a neoplasm of the original structure, and also in the selfsame tissue. In other words, this filtrate exemplified the strictest tissue and species specificity. Like results were induced when the tumor tissue was kept for some time in glycerinated extract or evaporated to powder form. Later on Rous studied hundreds of spontaneous chicken tumors, and found two others which would also reproduce a new growth when the filtrate was injected. This presumption that in the chicken sarcoma we are dealing with a filterable virus has been carried somewhat further and confirmed by Gye.

He claims that the infectivity of the Rous tumor persists for two to four days,

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though anaerobic cultivation preserves the infective substances for six to nine days, especially if fresh rabbit serum is added to the culture medium. From his experimental results with the injection of filtrates of anaerobically cultivated tumor tissue, he formulates the hypothesis which seems very ingenious, however revolutionary it may be to our preconceived views concerning the etiology of cancer. According to Gye, two separate agents are responsible for the production of tumor growth. One, he points out, is a filterable, ultra-microscopic virus, common to all tumors; the second, an accessory, unstable chemical agent, peculiar to each tumor, and also to each tissue, which he calls "the specific factor." In other words, the virus, he thinks, is nonspecific, and can be substituted by a virus from mammalian tumors or from tumors of totally different histological origin, as for instance, a carcinoma. The specific factor, on the other hand, he asserts, is peculiar to each tumor and plays the most essential part in the production of the tumor. For example, the specific factor of chicken sarcoma plus the virus of mouse carcinoma will reproduce chicken sarcoma conforming in every detail histologically and pathologically to the tumor from which the specific factor was derived. Gye stresses the importance of the specific factor as the decisive agent in the origin of neoplasia. While the combination of these two agents is essential, it is the specific factor which determines the specific structure, and the histological and biological character of the tumor. The virus itself plays a lesser rôle, as it can be substituted by a virus from an alien animal.

In order to confirm his contentions, Gye attempted to separate the two factors and to prove that the presence of the virus alone is unable to bring about tumor formation. So, too, the specific factor alone will fail to produce a tumor. When, however, the two factors are recombined, the relationship of the two causative agents is restored and thus promotes the development of a new tumor. A great many experiments were done in an attempt to make tenable these contentions. Up to the present, however, its acceptance must await, (1) confirmation of the experimental results; (2) the isolation of the two separate agents, and (3) whether they apply in the causation of cancer. Though the filterability of the Rous tumor had been established for several years, attempts to filter the active agents of mouse or rat sarcomata had been unsuccessful. With this end in view it became of the greatest importance to verify or disprove the crucial points of his experiments, especially his results on the filterability of mouse tumors. The following experiment was done with the mouse sarcoma No. 37, of the Imperial Cancer Research Fund of London.

The tumor bearing animal was killed with illuminating gas, the carcass dipped in lysol, a flap of skin reflected, and the exposed tumor removed with a cautery. One to 2 grams of this tumor tissue were placed in a tube containing 5 c.c. of Hartley's broth to which 1 c.c. of rabbit serum had been added, and this was incubated anaerobically in a Macintosh Fildes jar at 36.5° C. for twenty-three to twenty-four hours. The anaerobiosis was effected by means of a vacuum pump with the subsequent forcing in of hydrogen gas, the absence of oxygen being indicated by the loss of color of a methylene blue solution in the jar. At the end of the period of incubation, the fluid in the tubes was pipetted off, and passed through a Berkefeld filter, type "N," which had been tested for impermeability against *B. pyocyaneus*, *B. prodigiosus*, and *B. coli*. The filter candles were again tested after the tumor filtration. One to 1.5 c.c. of this filtrate together with a trace of silica, was injected subcutaneously into 183 mice, of which 8 developed tumors of the same histological structure as the original mouse sarcoma No. 37. These tumors appeared on the average twenty-three days after the injection of the filtrate in contrast to those produced by the inoculation of tumor fragments which develop regularly within seven to nine days after implantation. Mouse sarcoma No. 37 is a spindle cell sarcoma, richly cellular, with a slight central necrosis. Upon inoculation it "takes" in practically 100 per cent. The tumor from the filtrate very closely resembles the stock tumor, though it is per-

haps more cellular, and is little if at all necrotic.

As a parallel to this experiment 51 mice were injected with Hartley's broth and rabbit serum with an added trace of silica. These tubes were treated in the same manner as described above for the production of anaerobiosis. In no instance has there appeared any evidence of tumors, or any inflammatory thickening following these injections.

The second experiment was concerned with the injection of supernatant fluid from the tumor cultures instead of the filtrate. The tumor tissue was incubated in Hartley's broth and rabbit serum, in the same manner as before. The tubes were then centrifuged for ten to twelve minutes at 2700 to 3100 revolutions per minute, and 1.5 c.c. of the pooled supernatant fluid was injected subcutaneously into 105 mice. Of these 34, or approximately 32 per cent, developed tumors. These tumors from the supernatant fluid appear, on the average, seventeen days after injection, in contrast to the stock tumors which appear generally seven to nine days after inoculation, and to the filtrate tumors which it will be recalled appear twenty-three days after injection. The histological picture of these tumors produced from the supernatant fluid is again like that of the original mouse sarcoma No. 37. Furthermore, tumors produced in this way from the supernatant fluid can be propagated by the transplantation of fragments of the tissue in the usual way, as can also the filtrate tumors, and are now in the ninth generation.

To clear up the question of whether there are any possible stray living cells in the supernatant fluid which are capable of forming tumors, a control experiment was done, in which some of the tumor tissue removed from the centrifuged sediment was itself inoculated into mice. This tissue was either washed free of broth by centrifuging for thirty minutes in several changes of Tyrode's or Ringer's solution, or was used without washing. The washed tissue was inoculated into 63 mice with 3 "takes;" the unwashed tissue was inoculated into 58 mice with 3 "takes." When we consider that the inoculation of the incubated tumor tissue itself results in so small a percentage of tumor "takes," it is most improbable that any stray cell in the supernatant fluid is sufficiently viable to be responsible for the tumor production in 32 per cent of the animals injected with the supernatant fluid.

Next, our experiments were directed towards the filterability of mouse carcinoma, using mouse carcinoma No. 63 from the Imperial Cancer Research Fund of London. The anaerobic cultivation and filtration were carried on under the same experimental conditions as with the mouse sarcoma No. 37. So far, in the 27 mice injected with the filtrate, we have not met with a single positive result. The supernatant fluid, on the other hand, produced 2 tumors in 81 mice injected, these tumors appearing on the tenth and fourteenth day respectively. Microscopically the carcinomata from the supernatant fluid showed the same histological structure as the original mouse carcinoma No. 63. These experiments with the carcinoma filtrate are still in progress, but have had to be curtailed on account of the difficulty of obtaining mice of the same strain.

To put these results in a more concrete form, let me repeat that the injection of the supernatant fluid from anaerobically cultivated cultures of the mouse sarcoma No. 37 yielded 32 per cent of tumor "takes." The tumors appeared on the average seventeen days after injection. Microscopically they closely resembled the parent tumor. As a control to this experiment, the possibility of cells remaining alive in the fluid was tested by inoculating the incubated tissue itself. Out of 63 inoculations of washed tissue, there were but 3 "takes;" out of 58 inoculations of unwashed tissue there were 3 "takes." If our results are due to the presence of living cells it is difficult to reconcile the 32 per cent of takes from the supernatant fluid with the very small percentage obtained from the inoculations of the incubated tumor tissue itself.

The acid test of ruling out the presence of cells in the incubated fluid was met by the filtration of the fluid through a Berkefeld filter "N," which had been tested against bacteria before and after filtration.

For the carcinoma we claim only 2 takes from the supernatant fluid, none from the filtrate. We are thus able to confirm Gye's experiments concerning the filterability of the mouse sarcoma No. 37, which in our hands yielded about 4 per cent of takes in the injected animals.

It seems to me that in view of the filterability of the chicken and mouse sarcoma, we are compelled to take a more active interest in the subject of filterable agents. As a matter of fact, the property of filterability is not a simple one. On the one hand, some microorganisms like the spirochetes pass very readily through bacterial filters. On the other hand, there are a number of undoubted ultramicroscopic organisms that cannot be filtered in the condition in which they occur. Filterability depends upon a number of factors, (1) the nature of the diluent, whether it be distilled water or saline, and (2) whether there is a firm union between the filterable substance and the tissue itself. Again the amount of adsorption of the filter candle plays a very important rôle. It has been shown that in the case of the chicken sarcoma, the degree of porosity of the filter influences the infectivity of the filtrate until in some instances it may become innocuous. Again the tumors themselves vary enormously in their filterability. In other words, the property of filterability is not fixed like the histological picture of a tumor. The difficulty in all this work lies in the number of variables, state of the tumor, sensitivity of the animals, quality of the candles, etc.

Further research in this work undoubtedly lies in the refinement of technique, and the elimination of experimental errors, so that methods can be standardized, and in this manner bring about uniform results.

From these experiments although they confirm the filterability of mouse sarcoma No. 37 in about 4 per cent, it is difficult at the present time to accept this small percentage of "takes" as due to two separate agents. Until it is possible to demonstrate failures by the destruction of one or the other agent in a much larger percentage of "takes" than we are getting now, this part of Gye's work must be held in abeyance. In the first place, it will be necessary to improve the technique to such an extent that we are enabled to obtain a higher percentage of takes, in order to establish a standard, say up to 40 and 50 per cent; secondly, after having set up a standard, then to test for the presence of the two separate agents.

Gye claims that chloroform destroys the virus, hence the filtrate becomes inactive. On the other hand, the destruction of the specific factor also renders the infective fluid innocuous. The burden of proof of the existence of two agents then rests upon the ability of the two substances when reunited to produce a tumor. Up to the present only one subsequent report by Cutler confirms the loss of infectivity of the Rous tumor by a standardized solution of chloroform incubated for four hours.

This experiment demonstrates that incubation of the filtrate for four hours or more with chloroform inactivates the filtrate. In other words, three hours' incubation does not destroy the virus sufficiently, as a growth will result. After four hours' incubation, however, no growth will take place. Up to the present no one has repeated the isolation of the specific factor.

All in all, then, we may claim that our filtrates of the mouse sarcoma No. 37 through a fine Berkefeld filter yields a cell free filtrate which upon injection into mice reproduces the original mouse sarcoma. What particular agent or substance is responsible for the tumor production, however, must rest upon the demonstration of substances which are specific *per se* or in combination with other substances in the production of a new growth.

In brief, then, this is the analysis of our attempts to cause the development of mouse sarcoma No. 37 by a cell free filtrate and is a partial confirmation of Gye's work. On the other hand, the interpretation of the adjustment of a nonspecific plus a specific factor has, not been corroborated, up to the present time although private information from sources here and abroad disclose the fact that there are many efforts afoot to isolate the etiological factors.

The germ theory of cancer is not a new one. Often has it been advanced, and as often been rejected. It has been pointed

out in the past and rightly so that it does not explain cancer. This view was justified at the time as no one had isolated an organism which when injected into an animal would reproduce with certainty a typical new growth. Not even now in the light of Gye's recent work can it be said that the presence of an organism by itself can account for the production of the fundamental features of a neoplasm. So far then the opponents of the germ theory are correct, if their contention rests purely on the basis that the cancer question cannot be solved by setting up wholly an extrinsic bacterial origin. In this much Gye also agrees that the extrinsic agent or virus by itself is incapable of producing malignant tumor formation. To do that it requires the coordination of the intrinsic factor, or accessory substances produced by the cells themselves. The intrinsic factor or accessory substance varies from tissue to tissue, and also from tumor to tumor.

The outstanding feature of this new research, to my mind, is the supposition of the close association of this accessory factor with an infective agent. Gye claims he is now able to reproduce the Rous tumor by combining the specific factor of a Rous chicken sarcoma with the virus of a rat, mouse or even human carcinoma. The physical and chemical properties of the so-called accessory factor are as yet not established, but possibly more knowledge of both agents may yield vital facts in the etiology of cancer, as for instance, sex or age incidence, selective localization the effect of chronic irritation, and the relationship between benign and malignant tumors, etc. It is as yet too early to expect that it will clear up the entire etiology of the cancer problem. At any rate these new discoveries of Gye open up an entirely new avenue of approach, and for the first time the cancer student has something tangible to work on.

THE PRESENT STATUS OF OUR KNOWLEDGE OF THE EFFECT OF IRRADIATION UPON THE GENERATIVE ORGANS AND THE OFFSPRING*

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WHEN I was asked to prepare a paper on the effects of irradiation upon the generative organs and the offspring, it occurred to me that it might be well to summarize, in a general way, our present knowledge of the subject and to express the reactions of a biologist to a biological subject of special interest to medical men. I shall not attempt to give detailed data on this subject, in which there is already an extensive bibliography, but to point out certain facts which are apparently well founded, and to caution against the indiscriminate use of irradiation by those not familiar with its biological effects, and to indicate certain phases of the subject in which there is still need of much careful investigation, both from a clinical and experimental point of view.

Several years ago Bergonié and Tribondeau formulated their so-called law of tissue susceptibility to irradiation, which states that immature cells, and cells that are actively dividing are more sensitive to roentgen rays than are the adult type of cells. Their observations were based on the tissue reactions of the rat's testicle, and since that time numerous investigators have extended the field to include other embryonic-like structures, the ovary and various malignant growths, and have shown that tissues behave to radium

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irradiation in a manner similar to that following roentgen irradiation.

It will not be my task to describe in detail the destructive histological changes that follow irradiation of the gonads. It is a well-known fact that in the case of the irradiated ovary that organ becomes atrophic, the Graafian follicles disappear, or become cystic, and while the germinal epithelium shows various degrees of degeneration, the corpora lutea are less readily affected. The seminiferous epithelium of the irradiated testis is one of the first structures to show destructive changes. This is associated with a degeneration of the cells of the tubules and the complete absence of spermatozoa. Of course these changes are dependent on the severity of treatment, and vary with the age and physiological condition of the treated individual, and the time following the exposures when the observations are made.

To my mind the weight of available evidence favors the conclusion that irradiation effects on living tissues are mainly destructive. Nevertheless, from the very nature of the situation, the biological response is far from simple; so that finally we find that irradiation is now being used all the way from destructive doses for malignant tissue, to irradiation over the ovaries for the control of uterine bleeding in young women, and even as a so-called "stimulating" dose for the treatment of sterility in the female.

This interesting situation brings up some important questions, but the answers to many of them are still hidden. Take, for instance, the effect of irradiation upon the ovary. Now if it be admitted that the effect upon that organ varies all the way from almost complete atrophy to a dose that only temporarily inhibits its function, then there is conceivably a point where ova may be partially injured, but not prevented from participating in the future development of an embryo. Have we any evidence to show that the progeny from such an ovum is actually injured? And, again, this same situation holds for the case of irradiated spermatozoa, and the same question must be answered for these cells. Leaving aside for the present the consideration of the human germ cells, I think it can be definitely stated that biological studies have shown that the germ plasm of the lower animals can be profoundly altered by sufficient irradiation and the progeny will suffer accordingly. We have only to go to the work of the Hertwigs to see the detrimental effect of radium irradiation upon either the unfertilized or fertilized ova, or upon the spermatozoa. One may say that these results may very well hold for ova of frogs, but what evidence have we that ova of mammals may behave similarly?

In regard to the effect of irradiation upon unfertilized ova of mammals, we of course have no experimental data concerning treatment of the ova alone, but studies of Lacassagne and Coutard with rabbits are of interest in this regard. Females were treated with roentgen rays and when later mated with normal males, produced defective offspring. I find that the still more recent work of Driessen in Germany tends to substantiate these results. The abnormal offspring noted by these investigators were found in the first generation animals. Would it be possible to treat the germ plasm of the parents with such a small amount of radiation that the first generation animals themselves would be normal, but their inbred descendants abnormal? Several years ago I attempted to answer this question in a series of experiments with Dr. C. C. Little. We found that when both the male and female parents of mice were irradiated with relatively light doses of roentgen rays all their offspring were apparently normal, but in certain instances the descendants of these mice were blind and showed defects of the limbs. These defects were inherited and were not found in the control animals.

Do the above results, for which I am partly responsible, mean the germ plasm of mammals may be modified at will by irradiation, or are the biological factors generally opposed to such a happening? Having raised such a question, I realized my responsibility to answer it, and so sometime ago, with the cooperation of Dr. E. C. MacDowell, a repetition was made of the original experiment. The experiments are still being continued, but the results to date have been unques-

tionably negative, although several thousand animals have been observed. These results do not mean that the first experiments were incorrect, but they show that the chances are against the possibility of modifying the germ plasm at will. The chances of a germ cell modified by irradiation to survive the competition of normal gametes and zygotes until maturity of the individual is probably very small. However, it is well to bear in mind that the occurrence is biologically possible.

When we consider the effect of irradiation upon the fertilized ova we are on much firmer ground. Many well-worked out experiments have shown that when the early developing mammalian fetus is irradiated with a sufficient intensity, and still with a dose which gives no appreciable effect on the mother, either abortion occurs, or gross arrests in development are found. The arrests include blindness or gross defects of the central nervous system or sterility, and generally there is a combination of all three.

We all know of the remarkable regressions that occur in certain very cellular tumors that have been irradiated, and we attribute the results to the fact that the tissue is composed of embryonic-like cells. What more natural thing to expect, than that an embryo itself would be arrested in its development by irradiation.

Several years ago Dr. Harold Bailey and the writer cautioned against the use of irradiation during pregnancy, and we were severely taken to task for our stand that irradiation, even when given during late pregnancy, was fraught with dangers. We admit that the apparent weight of evidence, as expressed in the literature, is against our view, although there is much to substantiate us. From a biological point of view this is exactly what one would expect.

After the various organ-systems have been laid down in development, and the sense organs have been fully formed there is little that irradiation of a fetus can produce that is visible at birth. Hence the numerous reports in the medical literature that state "the child at birth was normal and showed no apparent defects." My own experiments with mammals, and those of many other investigators, have shown that irradiation effects in fetuses treated towards the end of pregnancy must be looked for in other situations. The clinical examination at parturition does not tell all the story. One must look ahead towards the future development of the child. The things to look for are disturbances in growth, late onset of ocular disturbance, especially lenticular opacity, the mental development, and finally whether or not the individual is sterile. These suggestions are based on numerous experimental observations, and are the conditions actually met with in animal studies.

Recently there has been an attempt to collect from the medical profession in general, statistical observations relative to the irradiation effects upon the fetus. Unless the observations are made by competent anatomists who know what morphological conditions to look for, and unless there is a so-called "follow up" of the children over a considerable period of time, the results may not only be erroneous but lead to an unwarranted feeling of security.

There is still much work to be done in the field of irradiation before we know exactly what effect the physical agents have upon the human reproductive system. I find that there is little agreement as to what actually constitutes the sterilization dose, and in fact when we consider the importance of individual idiosyncrasy, I do not believe we actually know what treatment it is necessary to give to produce complete sterility with a minimum exposure to the tissues surrounding the reproductive organs. It is well known that in both sexes irradiation may produce a so-called temporary sterility, but frequently the radiologist is surprised with the late return of functional activity.

There is a general belief that irradiation of the ovary must be proportional to the functional activity of that organ in order to produce the desired effect. The lower the activity, the smaller the dose that entirely destroys any function that is left.

The time at my disposal does not permit of an extended discussion of my topic, but briefly to summarize the facts, I believe that:

1. Irradiation of the unfertilized ova or the spermatozoa may result either in completely destroying the functional activity of these cells, or so modifying their structure that the resulting offspring may be defective.

2. In this regard the evidence points to the likelihood of the death and absorption of injured germ cells, rather than their ability to compete with similar cells that have escaped injury.

3. There is, however, experimental evidence indicating that in certain instances the germ cells may be modified by irradiation and actual hereditary abnormalities established.

4. Irradiation of the fertilized ova, and irradiation during early pregnancy is likely to produce a marked arrest in development with subsequent modification of structural expression.

5. Irradiation during later pregnancy, while it may not produce visible changes in the offspring at birth, must cause one to look ahead to the future development of the child for disturbances in growth, loss of fertility, etc.

6. At the present time there is apparently no agreement as to what constitutes a sterilization dose for human beings, and a considerable amount of clinical and experimental investigation is still needed in this field.

DISCUSSION ON PAPERS BY DRS. FAILLA, SITTENFIELD AND BAGG

DR. HENRY J. ULLMANN, Santa Barbara, Calif. The work of Dr. Failla is so fundamental and complete that it would be presumptuous for me to attempt to discuss it.

Dr. Sittenfield's work is a wonderful stimulus for discussion, as is any work on the origin of cancer today. I was reminded of Miss Slye's work, and I thought if Dr. Sittenfield had had a known strain of mice which were susceptible to carcinoma, as some of her mice are, that he might have had 75 to 80 per cent of takes. That brings up the thought that three factors are involved in the production of cancer, and should be considered in any experimental work; (1) the strain of animal, not a strain in which the pedigree is known but a strain in which there is the highest percentage of takes of a given tumor under experiment; (2) the irritant, which may be bacteria, tar, or trauma, and (3) the unknown substance which seems to be much akin to the vitamins. Some individuals apparently do not develop this vitamin, or substitute for vitamin, and this may be developed in them by irradiation, for instance the ultraviolet. I will not go into this because I think Dr. Ernst can better discuss it. I believe it is of great importance.

I am greatly interested in Dr. Bagg's paper as we are doing something along that line in Santa Barbara. It is well known that a young animal, if given certain doses of roentgen rays, will grow faster than the control for a time, but if irradiation is stopped the control will catch up. This has not been carried on for successive generations. My 100 per cent dose unit was checked by Dr. Chamberlain and found to be approximately 1300 e. A male rat given 0.50 of this unit over a period of twelve weeks, 0.034 at each radiation, once a week for nine weeks, and for three weeks double that, grew the fastest of three males. The other male received 0.02 of this unit a week for three weeks, making a total of 0.76. The first female was irradiated for thirty-seven weeks, receiving seventy-five doses, twice a week, giving the exact total of the second male. She had pups in November, after this thirty-seven weeks. One was born dead and the others died the next day. She has not been irradiated since November, and had a healthy set of pups in March. The male parent was one of the two treated. The other female received a daily dose of 0.0034 for forty-eight days, a total of 0.16 unit. She grew the faster of both females, and was not irradiated after April. She had five pups on October 7 and she ate them all. She died in labor in November, 1925, having had four born, one protruding, and two found dead in the uterus. There is no comment on that. This work will be carried on for successive generations.

DR. CURTIS F. BURNAM, Baltimore. We owe a great debt to Dr. Failla. His contribution is a fundamental one. Through his kindness my associates and myself in Baltimore have been able to use these gold filter tubes, and I believe that there is much less destruction of tissue than when bare glass tubes of emanation are used. I should like to know if Dr. Failla has endeavored to reduce the amount of necrosis by using larger unit volumes of tissue and greater amounts of radium per tube than is done in the 1 cm. technique. This particular method we have employed in using bare glass tubes, and have certainly obtained better clinical results in many cases, particularly in carcinomatous glands of the neck. Often as much as 30 mc. are implanted in a single tube. Metal covered tubes ought to be of further advantage with this technique.

Has Dr. Failla compared the relative filtration values of platinum and gold?

Dr. Bagg's paper was most interesting and suggestive. The effect of radiation in producing sterility, or abnormality in the offspring, has been a real problem to those engaged in irradiating fibroid or bleeding conditions. In our work, in the early days, we were more careless than now, and the question of sterilizing nurses and technicians employed in transporting and making radium applicators, was a vital question. We had the misfortune to have a technician, who had been pumping radium emanation for two years, die of an aplastic anemia. The man originally was an anemic specimen, had infection of teeth and tonsils, and it was a question whether the anemia was a result of exposure to radium or simply an accidental occurrence. During the period of his anemia his wife became pregnant. As we had observed in a number of our workers either amenorrhea or aspermatozoa without any evidence of anemia, the fact that he had no aspermatozoa was taken as evidence that he had not had undue exposure to radium.

At the present time exposures are so carefully guarded against that we have ceased seeing either of these two conditions.

Dr. W. H. Cameron, Pittsburgh, Pa. I wonder if anyone is familiar with the work of Kolmer of Philadelphia, following Gye's work. In the specific factor he always adds three drops of chloroform, and found that this would sometimes give takes, but when sufficient chloroform is added there is no take whatever. He concludes that there has been so large an element of error in Gye's work that it cannot be accepted at all.

Dr. Burton T. Simpson, Buffalo, N. Y. At the State Institute for the Study of Malignant Disease at Buffalo, where we repeated Gye's work we found that if we followed Gye's technique exactly we obtained the same results as he did. However, if we varied them somewhat we would get different results, for instance, with 1 c.c. of the chloroform sand filtrate we obtained no tumors, but if we used 2 c.c., tumors would appear. Also, if we incubated the sand filtrate with just the right amount of chloroform but agitated it by stirring every few minutes, it was impossible to produce a tumor with any amount. Gye believes that the specific substance is also influenced by chloroform and if too great a concentration is used this will destroy not only the virus but also the specific substance which would be the answer to Dr. Cameron's objection. At the recent meeting of the American Association for Cancer Research, Dr. Cutler, who had worked with Gye in London read a paper describing work done by him which he believed corroborated Gye's work. However, there were several other men who had also repeated Gye's work who discussed the paper and concluded from their experiences that Gye's work could not be substantiated. In our experience we have found that we could activate the chloroform sand filtrate with cultures of embryonic tissues. It is a recognized fact that the chicken sarcoma is quite different from any other type of malignant neoplasm of which we know. In all other transplanted tumors the neoplasm is the result of carrying over of cells from the original tumor and these grow in the body of the host although with the chicken sarcoma a cell-free filtrate produces a new tumor in the host. It is possible that the mouse sarcoma which Dr. Sittenfield has worked with may be a similar neoplasm.

It appears to me, especially as all the tumors produced by Gye by his technique were chicken sarcomata, that the treatment by chloroform has inhibited the virus and that the subsequent treatment by cultures which contained embryonic tissue, has again activated the virus. In any event, it seems very improbable that a single microorganism could produce all types of malignant tumors.

Dr. F. M. Johnson, Atlanta, Ga. I wish to offer my congratulations upon the papers presented this morning, especially Dr. Failla's. Through his kindness and that of Dr. Quick, a few weeks ago I was supplied with some of the gold tubing, and although the time has been short, I think the difference in results certainly merits particular consideration. I have used them in two distinct classes of lesions, carcinoma of the cervix uteri and mouth cancer; although similar histologically the different locations make them entirely different from the standpoint of treatment. The uterine tumors have responded well, and I have had no sloughing. Neither did I have sloughing in using the glass tubes, so I am not sure the gold tubes are a distinct advantage in cancer of the cervix, but time will tell. Of the mouth tumors, one was a very hopeless carcinoma of the cheek. I treated a small area of the lesion only, and from Dr. Failla's figures as given this morning, I can see wherein I erred, in that I used about twice as much radiation as I would have used with the glass tubes. In this instance, there was a very serious breaking down of tissue with all the bad effects of the old glass tubes. In another case, a cancer of the mucosa of the jaw, the gold tubes used were about one and a half times as strong as equivalent glass tubes. Strange to say, the tumor healed almost at

once, and although the time has been short, the result is very pleasing and leaves hope for the future.

I have noticed that with the glass tubes, the mouth lesions that heal so very promptly often break down at a later date following a secondary radium effect. I wonder if the same sequence of events can be expected when gold implants are used?

DR. E. H. SKINNER, Kansas City, Mo. I wish to discuss Dr. Bagg's paper in relation to the effect upon the growth of individuals, especially in the application of radiotherapy to children or infants. I have observed in cases of thymus enlargement that I have treated that these children do not have the development of lymphoid tissue which is comparable to the average child. In several of the thymus cases I have treated in the first to third week of life, these children as they have grown up (some of them are now ten and twelve years old) have not had tonsils or an appendix which I could fill with barium, and we know children's appendices do fill readily with barium.

I saw an abstract in the literature of a case reported by a German radiologist who had treated a child aged five for a fibroid tumor of the breast. The tumor receded, but the child at seventeen or eighteen has a shrunken breast upon the treated side, and a normal breast on the other side. I think we should take a far look at these children we are treating.

I wonder whether patients with tuberculous glands of the neck that we have treated have shown deformities or atypical development later in life. I wonder whether the patients with angiomata around the eyes, the jaws and forehead show any changes in development as they grow up. I believe this is a question which merits great thought and investigation.

DR. HENRY SCHMITZ, Chicago. I have been greatly interested in Dr. Bagg's paper. It has been my contention that the production of sterility in women by roentgenotherapy differs from that of intra-uterine treatment with radium. If we study the distribution of the intensities of radium, that is the isodoses, then with a 1200 mg-el-hr. application of radium a 10 per cent dose is obtained at the ovaries, if we assume the dose at 1 cm. from the center of the capsule to be 100 per cent. Hence we do not even destroy the maturing follicles of the ovary—the most radiosensitive portion of this organ. If we apply 25 to 35 per cent of a skin erythema dose a temporary cessation of ovulation is produced; while a 50 per cent skin erythema dose will produce a permanent cessation of ovulation. Radium acts by destroying the endometrium, leaving the ovaries practically intact, while roentgen rays destroy the ovulating elements of the ovaries leaving the uterus practically intact.

As to the second point, it makes a great deal of difference whether we irradiate a pregnant uterus or a non-pregnant uterus. I have under my observation in Chicago 3 children of women who were supposed to have been sterilized with radium. They afterward became pregnant and had full term children. Two of the patients were the wives of doctors. I have observed these children over a period of seven and ten years and cannot see any evidence of abnormality in them.

It is my contention that if we must use radium or roentgen rays for sterilization, then let us perform a complete sterilization just as a surgeon would by a hysterectomy and thereby prevent future pregnancy. A surgeon would remove the body of the uterus, leaving the healthy ovaries. Furthermore women during the child-bearing period of their lives, say up to thirty-five or forty, should not be treated with radiation for bleeding uteri if we can use other means of helping them. I believe it is poor treatment to submit a young woman to even a temporary sterilization.

If we observe the indications strictly that have been brought out this morning I feel that we will not produce monstrosities in the offspring that these women may have.

DR. DOUGLAS QUICK, New York City. Dr. Johnson asked about the destructive effects of filtered and unfiltered tubes buried. I think that depends very largely, particularly with gold tubes, upon the ultimate effect of gamma radiation on the blood supply. It is not evident in some instances for months afterward. A case will go on, apparently without any necrosis at all, and then just as it reaches the borderline some little thing will happen. If the tongue, it may be scratched or bitten and then the whole thing breaks down. I think that happens much more infrequently with the filtered than with the unfiltered tubes and that it happens further along in the case.

DR. FAILLA (closing). In order to answer Dr. Burnam's first question it is necessary to know the total amount of radon which one would use to treat a tumor of a given size with (1) one single tube centrally placed, and (2) a number of weaker tubes. *If the total millicurie dose is the same in the two cases*, there is little choice between the two methods in that the *total* volume of necrotic tissue is about the same. This applies to cases where the total dose is not larger than 10 or 15 mc. For larger (equal) total doses probably the single tube would produce less necrosis. We have made no

comparison of the single and distributed sources as regards the relative amount of radon required to treat effectively a given tumor. One would expect, however, that a smaller total amount of radon is required if several sources are used. In this case then less total necrosis would be produced. At any rate, irrespective of these considerations, we believe that in practice it is desirable to distribute a number of tubes within the tumor mass to make sure that sufficient radiation reaches the periphery.

As to Dr. Burnam's second question relating to the comparison of gold and platinum filters, I wish to say that we have not made platinum implants of the type described here. We have, however, used platinum and pure gold needles of the same thickness, and as far as one can tell, they produce the same effect. Furthermore, we have made extensive physical experiments to compare the radiation transmitted by different filters, and we find pure gold and platinum to be equivalent, within the limits of experimental error. If there is a difference, it is not greater than 5 per cent.

COMPARISON OF THE EFFECTS OF UNFILTERED AND FILTERED RADON TUBES BURIED IN RABBIT MUSCLE

BY MAX CUTLER, M.D.

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NEW YORK CITY

AFTER Failla had succeeded in collecting radium emanation in gold capillary tubes small enough for permanent insertion into tumors the question of dosage naturally presented itself. On the basis of previous work done in our laboratory[2] it was decided that animal experiments would supply considerable data for dosage purposes. Accordingly experiments were planned with the following objects in view:

1. To study and compare the biological effects of unfiltered and filtered buried radium emanation upon normal animal tissues.

2. To determine the effect upon the character and extent of the lesion by varying (*a*) the strength of the radioactive source; (*b*) the degree of filtration, and (*c*) the duration of irradiation.

3. To study the process of repair and ultimate fate of the lesion produced by the radioactive source.

For the study of tissue changes produced by a buried source of radiation the tissue selected must possess certain qualifications: It must be relatively radioresistant if the caustic effect of the radiation is to be observed; it must be uniform over a sufficiently extensive volume to permit a comparison between the zone of reaction and the surrounding normal tissues; it should be easily accessible so that the emanation tubes can be accurately centered. The lumbar muscles of the rabbit have been found in former experiments, in this laboratory and in others[1,2] to fulfill these conditions and have been used in these experiments.

Procedure

The millicurie value of each tube having been previously determined by means of the electroscope, the tubes were sterilized in 95 per cent alcohol. An area about 10 cm. long and 3 cm. wide overlying each lumbar muscle and parallel to the vertebral column was shaved and painted with iodine. The animal being held by an assistant, the skin was pierced at two points over each lumbar muscle by means of a sharp pointed scalpel, prior to the insertion of the tube. The preliminary piercing of the skin was found of distinct value in accurately placing the tubes, since in the introduction of the trocar into the center of the lumbar muscle, the greatest resistance to the puncture is offered by the skin. The force necessary to overcome this resistance frequently

so disturbs the animal as to render the accurate centering of the tubes difficult. By first piercing the skin with a sharp scalpel this difficulty is avoided. After loading the trocar whose plunger had been partly withdrawn it was inserted through the opening previously made in the skin and gently pushed through the aponeurosis perpendicularly into the estimated center of the lumbar muscle. The trocar was then deflected downward as far as possible and pushed forward in the longitudinal direction of the muscle fibers, and as nearly parallel to them as possible. When the point of the trocar had reached the desired position the plunger was pushed home and the trocar gently withdrawn. In this manner four tubes were placed in each animal, the tubes were left within the muscles and the animals sacrificed at varying intervals. The muscles were then removed and the lesions examined.

According to Lacassagne the structure and extent of the lesion produced by the same initial intensity of radiation is the same whether the tubes remain in the animal for one, three, seven or fifteen days. In his experiments the lesions apparently reached their maximum diameter at the end of twenty-four hours. In our experiments the animals were sacrificed after intervals varying between seven days and four months.

The animals were killed by a sharp blow on the neck and the lumbar muscles immediately removed. By holding the fresh muscles in front of a strong artificial light the exact location of the lesion was determined. By means of a sharp scalpel the muscle was sectioned, an attempt being made to strike a plane perpendicular to the tube and midway between its extremities. The incision was extended down to the tube and by partly separating the cut edges the tube was removed by means of fine forceps and the section of the muscle completed.

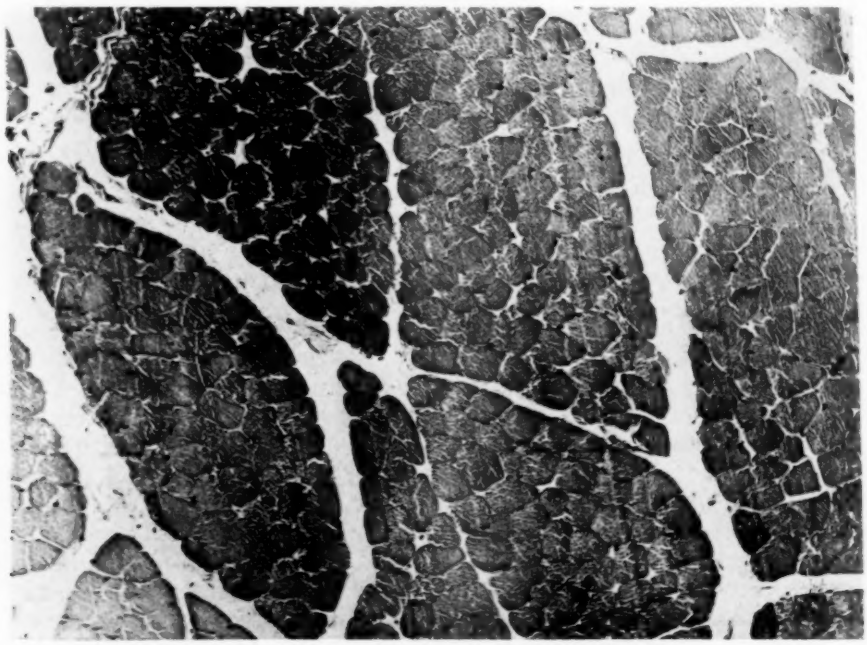

FIG. 1. Photomicrograph showing normal rabbit muscle.

A block of tissue approximately 4 mm. in thickness was cut from either side of the divided muscle. The diameter of the lesion presented by each of the four surfaces was determined and the largest diameter was taken as the maximum diameter of the lesion. By this procedure a double purpose was accomplished; blocks of tissue of a proper thickness for paraffin sections were obtained, and examination of the four surfaces in the close vicinity of the center of

the lesion permitted a fairly accurate determination of its maximum diameter. The measurements were made by means of fine calipers. Four determinations were made on each surface and the average value taken as the mean diameter of the lesion.

The blocks of tissue were fixed for twenty-four hours in 10 per cent formalin and carried through the routine paraffin technique. The sections were mounted and stained with hematoxylin and eosin.

be divided into three concentric zones. The central zone is circular in outline, dull gray in appearance and homogeneous throughout. Its consistence varies from slight softening to complete liquefaction. The area immediately in contact with the tube shows the more marked effect. The middle zone has a whitish opaque appearance, is homogeneous, firm in consistence and is sharply limited peripherally by the outer zone, or zone of hyperemia. The hyperemic

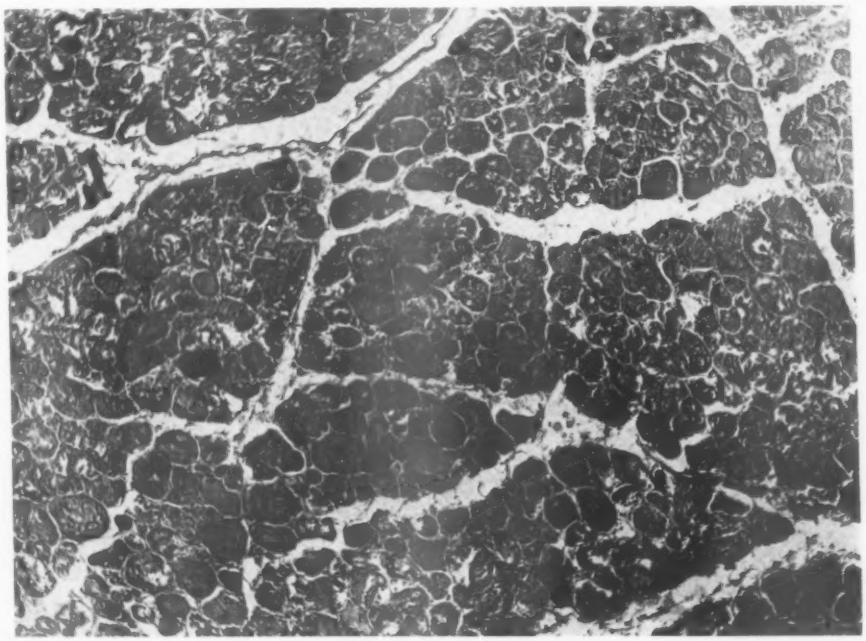

FIG. 2. Photomicrograph showing complete or caseation necrosis. The nuclei are completely destroyed, the muscle fibers show marked degenerative changes and are covered with fragmented nuclear material. At some points there are areas of liquefaction necrosis.

RESULTS

Gross lesion produced in muscle tissue by unfiltered and filtered buried radium emanation.

Examination and measurements of the lesion were carried out when the muscle was still in its fresh state. Because of distinct differences in the gross appearance of the lesion produced by bare tubes and gold tubes, the two will be described separately.

Bare Tubes. The lesion produced in muscle tissue surrounding a bare tube presents on cross section a sharply limited and distinctly outlined circular disc whose diameter varies with the initial strength of the tube. The area of tissue reaction may

reaction is most intense centrally and gradually diminishing in intensity as it extends outward becomes lost in the surrounding tissues. Beyond this the muscle tissue is macroscopically normal.

Gold Tubes. The lesion produced by a gold tube presents on gross examination two distinct zones: central and peripheral. The central zone is whitish, opaque, firm and homogeneous, circular in outline, occupying the entire area between the tube and zone of hyperemia. The latter is distinctly marked in the lesion produced by gold tubes of 0.2 mm. thickness and very indistinct or altogether absent when the gold filtration is increased to 0.3 mm. No

uniform or constant relation between the initial strength of the tube and the extent or intensity of the zone of hyperemia could be made out.

Histological Changes. Histological examination of the lesions produced by bare tubes and gold tubes showed that the reaction of the muscle tissue was distinctly different for the varying filtrations. It was also seen that the various zones of reaction noted in the gross specimens were represented by corresponding histological pictures. The following three types of tissue reactions were recognized to a varying extent in all the lesions regardless of the filtration, and will be described in detail.

(*a*) Zone of complete or caseation necrosis.

(*b*) Zone of partial or coagulation necrosis.

(*c*) Zone of hyperemia.

(*a*) *Zone of Complete or Caseation Necrosis.* The tissue immediately in contact with the radioactive source and extending peripherally presents a histological change which has been termed the zone of complete necrosis or caseation necrosis. This reaction of the muscle tissue is present in the lesions produced by gold tubes as well as in the lesions produced by glass tubes. The extent of this reaction, as will be shown later, is dependent upon the degree of filtration and strength of the radioactive source.

In this area the muscle fibers show the most marked changes, the normal wavy striations have entirely disappeared, the

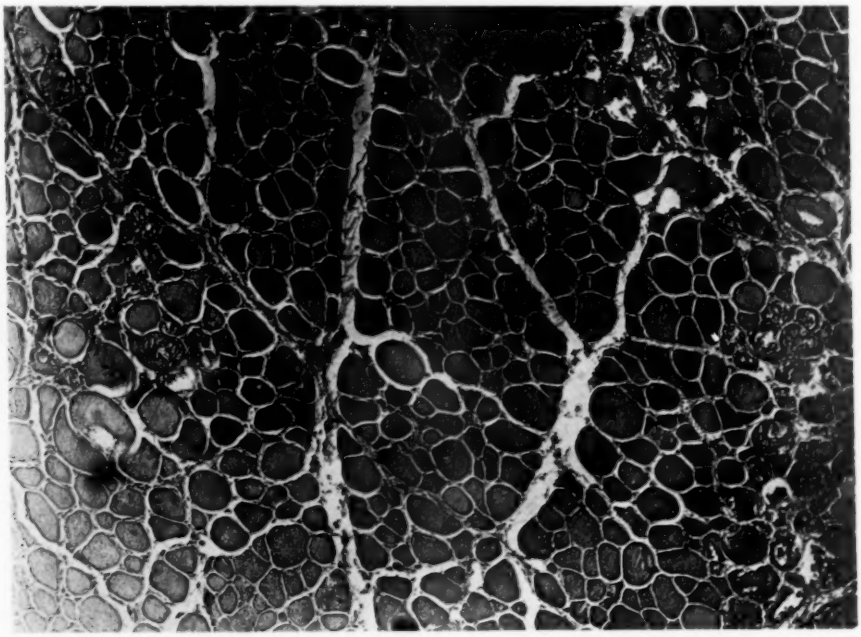

FIG. 3. Photomicrograph showing partial or coagulation necrosis. The muscle fibers show hyaline degeneration, there is no fragmentation of nuclei, the arrangement of the muscle fibers is undisturbed.

architecture is lost, the cytoplasm shows signs of marked degeneration, pulverized to dustlike granules, the cytoplasm is impregnated with nuclear dust and has taken a deep hematoxylin stain. The intensity of the reaction is more marked in the tissue immediately in contact with the emanation tube than peripherally. This muscle transformation is interpreted as a complete or caseation necrosis.

(*b*) *Zone of Partial or Coagulation Necrosis.* The zone peripheral to the area described above and lying within the zone of hyperemia presents a tissue transformation which has been termed a partial or coagulation necrosis. This area corresponds to the lightly staining zone seen in the mounted section by transmitted light. It is circular in outline, distinctly limited peripherally

where it is sharply separated from the zone of hyperemia and centrally where its separation from the area of complete necrosis is also sharply defined.

In this area is encountered a zone of muscle transformation of an entirely different character from that described above as caseation necrosis. Here the reaction of the tissue is less intense, the arrangement of the muscle bundles is undisturbed, the architecture is retained, the individual muscle fibers have lost their normal wavy striations and have undergone a hyaline transformation. The nuclei are for the most part intact, the cytoplasm has taken the eosin stain and lacks the basophilic appearance described above. This muscle change has been termed partial or coagulation necrosis.

(c) *Zone of Hyperemia.* Sharply separating the zone of partial necrosis from normal muscle tissue is a zone of hyperemia. This area corresponds to the zone of discoloration which is particularly well marked in the fresh muscle. In this area the smaller blood vessels and capillaries are dilated and filled with blood. There is extravasation of blood into the adjacent muscle tissues. The area of vascular dilatation and congestion forms a circle, sharply dividing the lesion proper from the surrounding normal tissues. The transition is sudden and may be distinguished in the gross and microscopically as a sharp circular line on one side of which the muscle shows radiation effect and on the other side a perfectly normal structure.

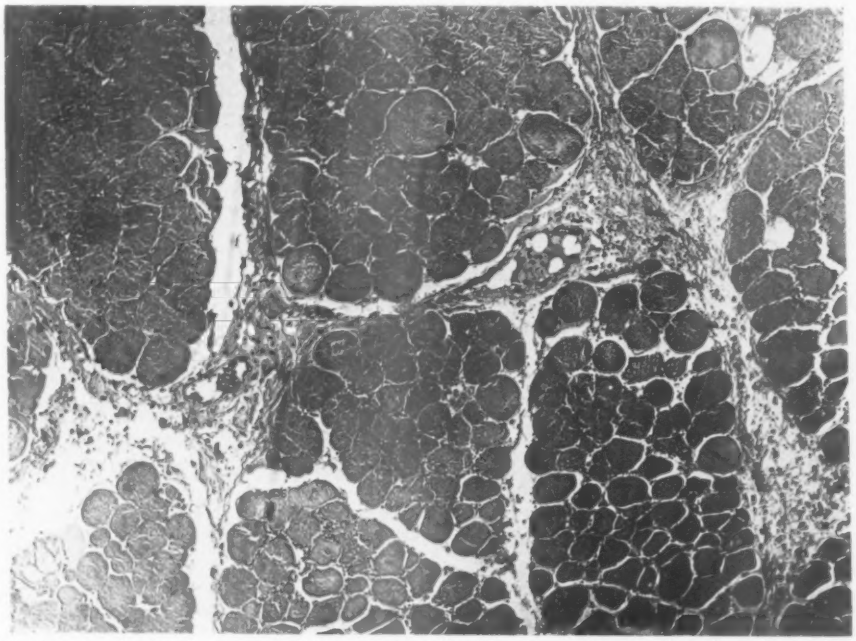

FIG. 4. Photomicrograph showing zone of hyperemia. The blood vessels are dilated and engorged with blood. There is some exudation of polymorphonuclear leucocytes and extravasation of blood into the tissue.

Effect of Filtration upon the Character of the Lesion

It was observed that by holding over a white surface a glass slide on which a thin lightly stained paraffin section of the lesion had been mounted, certain distinct concentric zones could be made out within the circular disc representing the lesion in the muscle. Two zones are visible; a central darkly stained zone and a peripheral lightly staining area. Microscopic examination of the tissue changes included within these areas revealed that the central zone corresponds precisely to the muscle change which has been described as complete or caseation necrosis, whereas the lightly stained area or peripheral zone corresponds to the zone of partial or coagulation necrosis. When the line separating these two

zones is marked on the slide and controlled microscopically it corresponds precisely to a sharp line of transition between these two reactions.

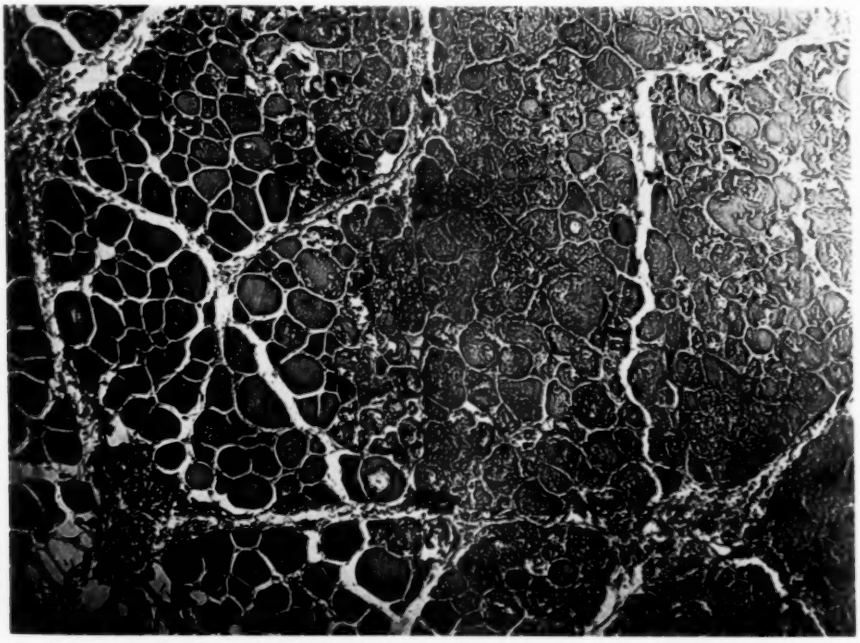

FIG. 5. Photomicrograph showing sharp line of division between the zones of partial and complete necrosis. Note the difference in the histological appearance of the two types of reaction. (A—partial necrosis and B—complete necrosis.)

For the presence of the two zones of varying staining intensity the following explanation is suggested: In the area of complete necrosis (*a*) the more intense radiation effect has caused a fragmentation of nuclei with the result that the chromatin material has diffusely covered the cytoplasm of the muscle fibers; because of this the tissue in this area has taken the hematoxylin stain more deeply. In zone (*b*) or zone of partial necrosis the reaction is less intense, the nuclei are intact, the cytoplasm is free of chromatin material, the tissue has taken more of the eosin stain and appears as a lightly stained area. Figure 6 is a diagrammatic representation of the appearance of the lesions as seen on the mounted slide with the naked eye, by transmitted light.

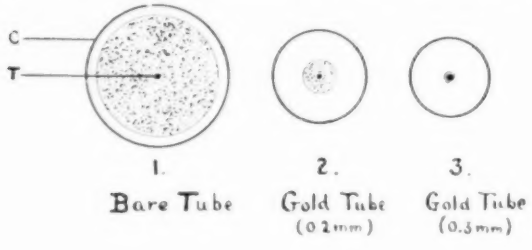

Fig 6.

FIG. 6. The lesions are drawn to scale (four times actual size). No. 1 represents the lesion produced by a bare tube of 5 mc.; No. 2, one produced by a gold tube (0.2 mm. filtration) of 5 mc.; and No. 3 one produced by a gold tube (0.3 mm. filtration) of 5 mc. T is the canal produced by the emanation tube; C represents the periphery of the lesion sharply dividing the lesion proper from normal muscle tissue.

It may be seen from the diagrams that the relation between the zones of complete and partial necrosis changes with the filtration. As the factor of filtration is introduced and increased the zone of partial necrosis becomes relatively larger so that whereas the lesion produced by a bare tube is chiefly one of complete necrosis, that produced by a gold tube of 0.3 mm. filtration is largely one of partial necrosis.

Effects of Intensity of Irradiation and Degree of Filtration on Extent of Lesion.

In order to determine the relation between the strength of the radioactive source and the extent of the lesion tubes of different millicurie values were used. Similar experiments were performed using bare tubes, 0.2 mm. gold tubes, and 0.3 mm. gold tubes. The diameter of the lesion was determined on the fresh specimen as previously described. The zone of hyperemia was not included in the measurements. The results thus obtained are given in Table 1.

TABLE 1

	Initial Value, Mc.	Mean Diameter, Mm.
Series 1 Bare Tubes Animals sacrificed on 14th day	1.55	7.2
	2.03	7.6
	2.25	6.9
	2.30	7.1
	3.43	9.4
	3.52	9.0
	4.58	10.0
Series 2 Gold Tubes (0.2 mm.) Animals sacrificed on 7th day	1.62	4.8
	1.62	3.37
	1.95	4.50
	2.25	4.65
	5.14	7.90
	5.57	7.32
	7.92	8.02
	9.33	8.60
	10.85	9.77
	12.18	10.37
	15.20	11.90
Series 3 Gold Tubes (0.3 mm.) Animals sacrificed on 7th day	2.63	4.17
	3.01	4.92
	4.38	5.66
	4.69	6.70
	5.01	6.27
	5.60	6.37
	7.02	7.67
	7.22	7.75
	7.99	6.80
	8.08	6.50
	11.03	8.85
	11.90	9.27
Series 4 Gold Tubes (0.3 mm.) Animals sacrificed on 14th day	0.59	2.50
	0.91	3.00
	0.99	3.80
	2.02	4.50
	2.09	3.90
	2.10	3.80
	2.11	3.80
	2.20	4.30
	3.11	4.90
	3.89	5.00
	3.92	4.50
	5.10	5.90
	5.12	5.80

By plotting the values obtained from experiments 1, 2, and 3 three graphs are obtained (Fig. 7) representing the relation between the initial millicurie value of the tubes and the mean diameter of the lesion with varying degrees of filtration.*

The values of the radon tubes in millicuries are plotted as abscissas and the mean diameters of the lesions in millimeters as ordinates. No. 1 is the curve for bare tubes, No. 2 for 0.2 mm. gold tubes, No. 3 for 0.3 mm. gold. Examination of the curves show that for each filter the amount of necrosis increases with the strength of the radioactive source, and that for the same initial millicurie value the amount of necrosis is less the greater the filtration. The data obtained from these experiments have been incorporated with other data and utilized indirectly for dosage purposes.

Process of Repair and Ultimate Fate of Lesion Produced by Buried Radium Emanation

METHOD

In order to determine the later changes in, and ultimate fate of the lesion produced in muscle tissue by the emanation tubes, experiments were performed in which the emanation tubes were abandoned in the tissues for longer periods. Four animals were employed in these experiments, two bare tubes and two gold tubes were placed in the lumbar muscles of each rabbit. Two animals were sacrificed at the end of four weeks, and two at the end of eight weeks, as indicated in the following table.

TABLE II

	Initial Value, Mc.	Diameter (Aver.), Mm.
Series 5 Bare Tubes Animals sacrificed after 4 weeks	2.8	7.6
	7.0	10.0
	3.6	8.0
	10.5	14.5
Gold Tubes (0.2 mm.)	6.0	8.0
	2.6	4.5
	6.0	7.5
	2.6	4.0
Series 6 Bare Tubes Animals sacrificed after 8 weeks	3.9	6.25
	7.4	9.00
	2.5	5.75
	7.6	9.00
Gold Tubes (0.2 mm.)	6.8	5.5
	2.6	4.9
	6.0	6.0
	2.6	4.5

*The values from Series 4 are not plotted as the curve would overlap Curve 3. This is due to the fact that for equal millicurie values and equal filtrations the extent of the lesion is the same at the end of seven days as it is at the end of fourteen days.

The average diameters given above refer to measurements of the lesion proper exclusive of the narrow rim of fibrosis which is approximately 0.5 mm. in thickness. The zone of fibrosis in Series 6 was definitely wider than in Series 5 and varied from 1.0 to 1.5 mm. in thickness.

Gross Changes. Examination of the lesions produced at the end of four weeks and at the end of eight weeks revealed certain changes which had not been present in the animals which were sacrificed earlier. The chief difference consists in a replacement of the zone of hyperemia by a zone of firm, gray and glistening fibrous tissue. The main lesion, particularly at its periphery shows a beginning calcification, the remainder of the lesion is firm in consistence and fairly homogeneous. At the end of eight weeks the peripheral zone of fibrosis has become distinctly more marked and more prominent, the lesion appears contracted and proves to be so by measurement, the process of calcification has extended more centrally and in some instances small punctate calcific deposits may be seen throughout the main portion of the lesion within the zone of fibrosis. These changes are present in the lesions produced by gold tubes as well as in those produced by bare tubes, the process of repair is relatively more pronounced in the smaller lesions. These changes are confirmed by microscopic study of the specimens. The inflammatory reaction which was so prominent in the earlier specimens has disappeared leaving only a slight lymphocytic reaction.

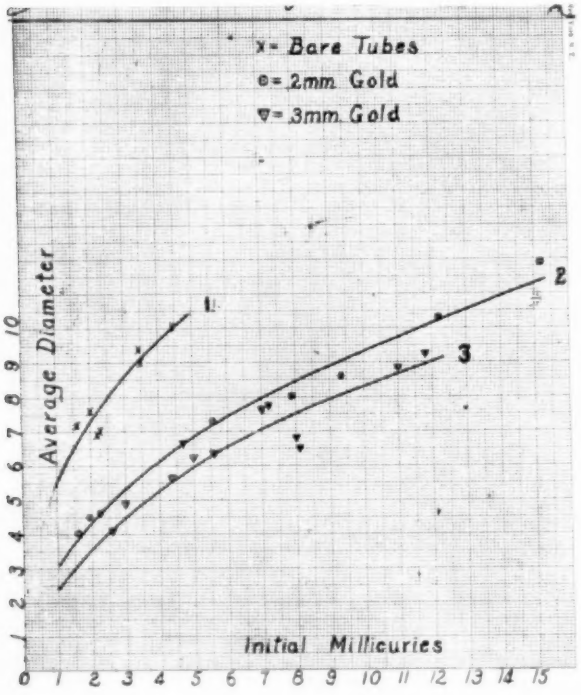

FIG. 7. (See text, page 541.)

DISCUSSION

The data obtained from these experiments are of value chiefly in demonstrating differences in the character of the lesion produced by glass and gold radon implants. As the filtration is increased, for equal millicurie values, the total volume of necrosis diminishes and the character of the lesion changes from one largely composed of complete or caseation necrosis to one of partial or coagulation necrosis.

Theoretically, the ideal type of radiation is that which causes effective regression of a tumor and at the same time preserves the surrounding normal structures. Histological examination of irradiated tissues has amply demonstrated that a favorable tumor bed reaction is one of the most essential factors in causing the disappearance of the tumor process.[1] The complete destruction of a bulk of tumor by the implantation of bare tubes can be accomplished; the total dose and distribution must, however, be such that the entire tumor mass is completely destroyed. Because of the intensity of the radiation produced by the glass tubes the tumor bed remaining after the slough has separated is a favorable site for local recurrence if outlying foci of viable tumor cells remain. It is believed that local recurrences following this type of irradiation may be attributed to the fact that either because of insufficient total dosage or faulty distribution, viable tumor cells remain in a tissue medium favorable to their growth. This view is supported by both clinical and histological evidence. Actively growing tumor tissue is frequently observed along the edge of an ulcerated area from which the main tumor mass has sloughed follow-

ing interstitial irradiation. Histological examination of such tissue reveals actively growing tumor cells in a dense avascular and acellular connective tissue bed, a condition which has been termed by Ewing "abortive fibrosis."[3]

Any type of radiation which is of sufficient intensity to produce an unfavorable effect upon the tumor bed, must depend for its action upon a complete devitalization of all tumor cells, if local recurrence is to be avoided. If by reducing the intensity of the local (beta) radiation, by the use of gold tubes, a more favorable tumor bed reaction can be obtained, outlying foci of tumor cells not completely devitalized might be expected to regress through the activity of the connective tissue, blood vessels, lymphocytes, and plasma cells. In this manner it seems logical that adjacent normal structures may be utilized as a defensive mechanism against local recurrences. Furthermore if the main tumor mass can be prevented from sloughing, secondary infection can be avoided and in this way one of the most undesirable features of the glass tube method eliminated. The correctness of these views can be determined only by careful clinical observations which are at present under way and will form the subject of a separate report.

The varying susceptibilities of different tumors to irradiation depending upon their biological and corresponding histological properties necessitates further studies to obtain direct and more accurate information for use in practical treatment. Such studies must be based upon an analysis of varying types of human tumors which have received radon implants and are later removed at operation. Information of this type combined with careful clinical observations by leading to more accurate dosage for each type of tumor, will form a more rational basis for the treatment of tumors by means of radon implants.

CONCLUSIONS

1. The extent of the necrosis depends upon the initial millicurie value of the radiation source and the degree of filtration. For each filter the amount of necrosis increases with the strength of the source. For the same initial millicurie value, the amount of necrosis is less the greater the filtration.

2. The degree and type of reaction produced by unfiltered and filtered buried radium emanation upon normal rabbit muscle differ. The effect produced by filtered radiation is less intense and consists largely of a partial or coagulation necrosis. The effect produced by unfiltered radiation is more intense and consists largely of a complete or caseation necrosis.

3. The process of repair consists of a contraction of the lesion with peripheral fibrosis extending centrally and a central calcification.

The writer wishes to acknowledge his indebtedness to Dr. G. Failla for suggesting the problem, to Dr. James Ewing for his aid in the interpretation of the histological material, and to Mr. Norris Goldsmith for his assistance in the experimental work.

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AN ATTEMPT TO APPRAISE THE ROENTGENOLOGICAL METHOD OF DIAGNOSIS IN PULMONARY TUBERCULOSIS*

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IN attempting to determine the relative value of the roentgenological diagnosis in pulmonary tuberculosis one is confronted with certain well-defined difficulties:

1. There is no reliable control by which the correctness or incorrectness of the roentgen diagnosis may be proven in all cases.

2. The personal equation, always a variable factor, is a confusing element. Roentgenologists vary in experience and in their ability to distinguish the normal from the abnormal lung field and to differentiate clearly the latter into the tuberculous and nontuberculous.

3. The chronicity of the disease and the fact that only a small percentage of cases of tuberculosis progress to death or even to an open state makes it difficult to follow them.

Despite these obstacles a study of this problem is undertaken not for the purpose of proving this method either more or less valuable than other diagnostic procedures, but rather to establish its proper relationship to other methods and to determine, if possible, the degree of reliability of the roentgenological report.

In 1913 the writer, in collaboration with Ernest T. F. Richards reported a series of cases which had been studied both roentgenologically and clinically for the purpose of evaluating certain roentgenological signs of tuberculosis. In that communication the following statement appears:

"In the light of our present knowledge a negative diagnosis in any suspicious case is not justifiable until a roentgen examination has proven negative to tuberculosis."

The statement was also made that the positive roentgen diagnosis while perhaps less dependable than the negative was none less an indisputable aid not only to the the recognition of the disease in its incipiency but to the observation of its progress in more fully developed stages.

With the accumulation of experience during more recent years the correctness of these deductions has been amply confirmed.

The purpose of the present study is to make an appraisal of the roentgenological diagnosis of pulmonary tuberculosis which may be of some value to the practitioner who wishes to know how much reliance to place on roentgenological reports. In this connection it must not be forgotten that in this as is every other branch of medical diagnosis, experience and a fair knowledge of the pathology and pathogenesis of the disease under consideration are absolutely essential.

Roentgenological diagnosis has suffered much through the employment of meaningless words in roentgen reports. The following is an example:

"*Chest:* Apices somewhat hazy, hilus shadows mediumly dense.

Right lung: Peribronchial thickening definitely increased, somewhat scattered. Some hilus thickening spreading to the apex and to the base.

Left lung: Peribronchial thickening increased, coarse in character, extending from hilus to apex and to base. No pathology at the pleura, mediastinum or diaphragm. Heart globular."

An analysis of this report shows that it is entirely meaningless and that no deductions have been or can be drawn from it. The same case came under the writer's observation at a later date and his report was as follows:

"The lung fields are apparently within the normal.

Conclusions: No evidence of pulmonary tuberculosis.

Diagnosis: Negative."

* Read at the Twenty-seventh Annual Meeting, AMERICAN ROENTGEN RAY SOCIETY, Detroit, Mich., May 17–21, 1926

Another case illustrating this tendency to use too many words is the following:

The first report of record, signed by, Dr. R. G. Allison, is in the writer's opinion, a properly phrased roentgen report. It is dated 11 15 20 as follows:

"There is no evidence of tuberculosis, or other infiltration or consolidation of the lungs."

The second report, from an Arizona sanatorium, is worded:

"Hila increased in density, and caseous nodules at each. The upper and middle lobe bronchi on the right and the upper lobe bronchi on the left are heavier than normal. Borders are studded. There is strong suspicion that the linear markings in the first interspace on the right reach the surface. The right main trunk bronchus is slightly heavier than normal.

Conclusions: Chronic pulmonary tuberculosis. Activity cannot positively be determined, but it is strongly suspicious in the first interspace on the right."

With this long report, the prognosis surely was most grave. An examination of the subsequent history however shows that the sputum was negative on twenty-one separate occasions. Also that a negative roentgen report was rendered by the writer in April, 1925.

Throughout this five-year period there were repeated clinical reports of "Chronic pulmonary tuberculosis, moderately advanced, quiescent."

The writer believes that roentgen-ray reports should be concise and not open to double interpretations. When in doubt as to the meaning of certain changes in the lung fields, these changes should be described as accurately as possible and the conclusions stated as "indeterminate."

For the purpose of the present study a group of 225 cases were segregated out of approximately 3,000 whose roentgenograms were examined by the writer in the service of the United States Veterans Bureau. This service offers special advantages for such a study for the following reasons:

1. Both negative and positive cases are kept under observation for long periods of time and pass in review periodically through the medical clinic when not hospitalized.

2. The completeness of the case records, both preceding and following the roentgen examination, make it possible to analyze the cases from beginning to end.

3. The fact that many of these men desire to be classed as tuberculous in order to obtain compensation makes it essential that objective evidence as derived from roentgen and laboratory examinations, as well as physical examination, be relied upon to the practical exclusion of subjective symptoms.

PROCEDURE

Beginning early in the year of 1923, a private record was kept of each case wherein the writer's roentgen report appeared to be at radical variance with the clinical diagnosis. The histories of these cases were later obtained from the Bureau files and reviewed. A search was made for evidence tending either to support or refute the roentgen report. Only those cases referred to the roentgen department with a tentative or positive clinical diagnosis of tuberculosis were included in the study.

In this group the roentgen diagnosis was either (1) "pulmonary tuberculosis;" (2) "negative," or (3) "indeterminate." (1) A diagnosis of pulmonary tuberculosis was made when there were characteristic areas of parenchymal infiltration situated in the upper lung fields and presenting a characteristic distribution; (2) a negative diagnosis was made when the lung fields were wholly within the normal from a roentgenological standpoint; (3) those cases which showed abnormal densities in the roentgenograms but densities which were not distinctly characteristic of tuberculosis in type and distribution were classed as "indeterminate."

The follow-up of those negative cases in which the clinical diagnosis was positive resulted as follows:

A "Follow Up" of 126 Cases Clinically Diagnosed Pulmonary Tuberculosis Despite Negative Roentgen Reports.

Period of observation included years 1922, 1923, 1924, and 1925.

In 39 cases the diagnosis was based upon subjective symptoms or past history.

In 84 cases the diagnosis was based upon the above plus physical signs.

In only 3 cases were there reports of tubercle bacilli having been found. Two of these were of doubtful accuracy.

There were no deaths due to tuberculosis.

A careful review of the completed histories of this group of cases reveals no conclusive or satisfactory evidence of pulmonary tuberculosis (healed or active) in at least 124 cases.

In drawing deductions from an analysis of this group several outstanding facts should be emphasized.

1. Although many of these men returned for periodical examinations and were roentgenographed repeatedly the roentgen report was always negative. This fact may be accepted as rather convincing evidence that there was no progressive pathological process, since a tuberculosis persisting for a period of months could not fail to manifest itself unmistakably in later stereoscopic roentgenograms.

2. The clinical evidence of tuberculosis in these cases is strikingly unconvincing.

3. Most of these patients were under observation for long periods of time only because they were under Government compensation, whereas in private practice they would have disappeared from observation after a short time.

4. There is a close correlation throughout between the negative roentgen findings and the negative laboratory and other objective findings.

The 3 cases in which there were laboratory reports of tubercle bacilli found in the sputum require special consideration. One of these three was doubtless a case of basal tuberculosis, a type of the infection which will be considered later in this paper. A second case shows one positive laboratory report and twelve negative reports within a short period of time. The clinical diagnosis of pulmonary tuberculosis in this case has since been abandoned. The third case has been repeatedly negative from a roentgen standpoint although tubercle bacilli have been found from time to time over a period of several years. The suspicion was recently aroused that this patient was substituting the sputum of a known tuberculous patient for his own in order to obtain compensation.

While it would be uninteresting to report a large number of case histories in detail it would seem profitable to outline briefly a few illustrative cases in which there were sharp differences of opinion expressed in roentgenological and medical reports.

CASE I. J. A. M. Roentgen examination negative.

Clinical Diagnosis: Chronic pleurisy, chronic bronchitis. Chronic pulmonary tuberculosis.

Subjective Evidence: Patient states that sputum is frequently blood streaked and that he coughs continuously. (There is no record, however, of sputum examinations having been made.)

Objective Evidence: A review of the history fails to show any physical signs characteristic of tuberculosis.

Comment: This case has been under observation for three years with a persistent diagnosis of tuberculosis. The last roentgen examination was made on March 27, 1925, and was still negative.

CASE II. D. B.

Roentgen Report, Jan. 13, 1925. "The lung fields are apparently within the normal. No evidence of active or recent pulmonary tuberculosis."

Clinical Diagnosis, March 21, 1925. "Chronic pulmonary tuberculosis, activity indeterminate."

Evidence Favoring Tuberculosis: Chest somewhat hyper-resonant over right side. Few scattered sibilant râles in the summit of the lower lobe. Breath sounds are broncho-vesicular throughout. Moderate dullness above second rib and third thoracic spine. Broncho-vesicular breathing and increased voice conduction.

Points against Tuberculosis: Ten sputum examinations negative for tubercle bacilli, the last dated May 6, 1925. Roentgen examination negative.

Remarks by Attending Specialist: "The history and physical finding at this time indicate a subacute non-tuberculous infection, particularly in the lower lobes. It will be necessary to await subsidence of the grosser physical findings to decide upon the underlying pathology which at present is obscured."

Comment: It is apparent that despite repeated diagnosis of tuberculosis a fair analysis of the case history strongly supports the negative roentgen report.

CASE III. H. W. Roentgen examination negative.

Clinical Diagnosis: "Chronic pulmonary tuberculosis; moderately advanced, active."

Evidence Favoring Tuberculosis: Pain in chest; shortness of breath; tires easily and has dizzy

spells; catches cold easily. Slight cough and expectoration; night sweats. His face feels flushed and hot in afternoon. Tuberculosis complement fixation positive, four plus.

Evidence Opposed to Tuberculosis: Reports of 28 sputum examinations over a period of years were negative. Temperature varies from 36° to 37°C. and pulse from 68 to 95.

Remarks by Dr. Geo. Daris on Oct. 6, 1924: "Findings in this case are insufficient to justify a diagnosis of clinical tuberculosis at this time."

Basal Tuberculosis. It is probable that adult tuberculosis having its origin in one base is not very uncommon. Fortunately for the reputation of the roentgenologist, the disease spreads to the upper lung fields very early. The writer believes that the diagnosis of a purely basal tuberculosis is difficult and frequently impossible until the more characteristic upper lung changes have developed. This difficulty arises from the fact (1) that normal lung markings are much more pronounced at the base, and (2) that other infections and pathological processes are more common in the lower lung fields and tend to produce changes which both simulate and obscure tuberculous changes. Thus a tuberculosis associated with bronchiectasis could not be recognized unless the former had spread to parts of the lung not involved in the bronchiectatic process.

The writer was fortunate in being able to follow with serial roentgenographic examinations a case of pulmonary tuberculosis (in which the first roentgen report was negative) apparently beginning in the lower lobe and spreading to the upper lung field after an initial hemorrhage. The first of the series shows no characteristic evidence of tuberculosis but there is a slight cloudy area in one base. Subsequent films show typical upper lobe changes. At each succeeding examination there were found new areas of involvement while some of the older areas showed a tendency to heal and clear up. This patient is now under sanatorium treatment and has exhibited all of the characteristic signs and symptoms of tuberculosis. At the present time the disease is clinically arrested and recent films show no progression.

THE POSITIVE GROUP

An attempt was made to "follow up" a segregated group of 96 cases diagnosed roentgenologically "minimal tuberculosis."

Of this group there was a definite record of blood spitting in 4; there was a characteristic temperature record in 59; there was found a history of previous tuberculosis in 11; there was a history of gassing in 7; tubercle bacilli were reported found later in 17.

The clinical diagnosis was reported as "pulmonary tuberculosis, chronic active," in 87 cases; "pulmonary tuberculosis, arrested," in 9 cases.

While these figures appear to show a 100 per cent clinical confirmation of the roentgen diagnosis, this is doubtless misleading since in some instances the clinical diagnosis was based solely upon the roentgen report.

Errors found in cases diagnosed roentgenologically "advanced" or "moderately advanced" pulmonary tuberculosis. Pneumoconiosis, 2 cases; pulmonary changes in cardiac disease, 1 case; Hodgkin's disease, 1 case; metastatic malignancy, 1 case.

When one attempts to evaluate the positive roentgen diagnosis of pulmonary tuberculosis he meets many difficulties and is confronted with many unanswered questions.

We have no infallible roentgen signs of tuberculosis which are always manifest in that disease and in no other. Neither have we any clearly defined rules by which the active lesion may be roentgenologically differentiated from the inactive or arrested lesion.

One writer says dramatically: "Show me a tubercle," but he fails to offer a roentgenological definition of a tubercle.

Another says with equal emphasis, "You must find the 'cone' or 'triangle,'" but here again we are dealing with an ill-defined thing, theoretically beautiful but not constantly demonstrable in known cases of tuberculosis.

The writer believes that the roentgen diagnosis of pulmonary tuberculosis is an art which becomes more accurate with the accumulation of experience and that even the most experienced will not escape a small percentage of error.

If one is too cautious he will not discover the early case and the method will lose much of its advantage over older diagnostic agencies. If one is too bold he may gain the undesirable reputation of making diagnoses on too slight evidence.

To avoid error on either side the loyal and intelligent coöperation of the physician in charge is essential. The roentgenologist is always a consultant whose province it is to assist the referring physician, and his opinion should be treated by the latter as a link in the chain of evidence being forged.

The question of activity is one which must be finally determined by clinical evidence. A given lesion may or may not have roentgenological characteristics suggestive of recent activity but appearances in this respect are frequently deceptive.

The province of the roentgenologist, as the writer would define it, is to discover the lesion and describe it as nearly as possible in terms of its pathological significance.

It is not his province to decide whether the patient shall be sent to a sanatorium, treated at home or merely be kept under observation.

There can be no doubt that home or even expectant treatment is much safer when controlled by serial roentgenological examinations.

Paradoxical though it seems, the writer believes it to be a fact that there is a higher percentage of error in the roentgen diagnosis of advanced tuberculosis than of the earlier lesions. This is because the lesions which simulate tuberculosis most closely are usually gross in character and involve large lung areas. The following conditions may be cited as examples of this: pneumoconiosis; Hodgkin's disease (infiltrating type), and metastatic carcinoma.

Since errors of this kind are quickly discovered by the careful clinician they are not serious ones except in so far as they tend to discredit the roentgenologist and the science which he espouses.

To avoid these gross mistakes the roentgenologist should strive to obtain a history of the case before rendering his opinion. This would at least serve to put him on his guard.

While it is perhaps true that lung diagnosis is the most difficult field of roentgenology, it is equally true that our science may occupy a preëminent position within this field if sufficient study is devoted to it.

While the roentgen diagnosis of pulmonary tuberculosis is by no means infallible, an experienced examiner will rarely be in error if he adheres strictly to definite and specific rules of interpretation.

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RESOLUTION IN PNEUMONIC CONSOLIDATIONS*

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THE duties and responsibilities of the roentgenologist in the diagnosis and prognosis of pulmonary diseases have increased tremendously in the past ten or fifteen years. As late as ten years ago many capable internists and specialists in diseases of the lungs were frankly skeptical as to the value of the roentgen ray in the diagnosis of pulmonary tuberculosis.

What a change has taken place. We are now asked to give, and in many instances are attempting to give, information which can rarely, if ever, be derived from a single pair of stereoscopic plates. The obstetrician sends in an early pregnancy and not only expects us to tell him whether the patient has a tuberculosis of sufficient extent to warrant a therapeutic abortion, but would like, in addition, an opinion as to whether an artificial sterilization should be done at the same time. The general practitioner who sends in a case of suspected tuberculosis, expects not only a diagnosis but a prognosis and would like an opinion as to whether sanatorium treatment is necessary or advisable. The surgeon sends in his pre-operative case to find out if tuberculosis is present, and if so, if it is of such extent and character that it would likely flare up after general anesthesia. The specialist in tuberculosis is less exacting, as a rule. He generally feels, and occasionally is, capable of doing his own interpretation. But he likes someone to share the responsibility in case the "good" lung develops a progressive lesion after a thoracoplastic operation has been done on his advice. The busy internist is least exacting of all. He looks on us merely as another test tube. We are expected to exclude a clinical type of tuberculosis with our plates with about the same degree of accuracy and speed as a negative Wassermann reaction excludes syphilis.

What has inspired this confidence which is being exhibited in our method of diagnosis? Chiefly, I think, the long, painstaking and careful observation of large groups of tuberculous patients, both clinically and by serial plates, by sanatorium physicians. The year after year follow-up of negative cases, showing an incidence of tuberculosis less than the normal expectancy, has strengthened the belief of the medical public in the value of a negative chest plate.

During the past ten years these sanatorium workers, notably Amberson, Dunham, Brown, Heise and Sampson have proved the following beyond any reasonable doubt: (1) That extensive caseous tuberculosis with cavitation may almost entirely disappear under treatment; (2) that extensive tuberculosis of the inflammatory or exudative type may entirely disappear, and (3) that the majority of localized exudative lesions clear up entirely.

These facts, however, have all been proven during the last five years. I well remember a medical meeting twelve years ago when Dr. Giffin of the Mayo Clinic in a discussion of a paper on the roentgen diagnosis of tuberculosis made a statement which impressed me deeply. We were then in the throes of peribronchial tuberculosis, linear interweavings, increased linear markings, hilus tuberculosis and many other descriptive terms of what we now know to have been nothing more than the shadows of normal anatomical structures. These were perverted somewhat by the long exposure and prone position then employed. The chief reason, however, for the employment of such terms was a desire on the part of the roentgenologist to hedge until such time as he could thoroughly familiarize himself with the normal chest and so separate them from the abnormal. Dr. Giffin's statement was as follows:

"We feel that the *x*-ray is the only method by which we can accurately exclude pulmonary tuberculosis. Conversely, a positive diagnosis can often be more accurately made by other methods."

Following him in the discussion I said:

"We are perfectly willing to accept a negative diagnosis of tuberculosis from *x*-ray plates,

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but in case slight changes are found, we feel a month or six weeks' clinical observation is necessary to determine the activity or non-activity of the lesion."

This was during the period when the foolish controversy on the relative merits of the stethoscope and the roentgen ray was raging. The advocates of each were striving to detect the lesion before the other, and little attention was being paid either to the etiology or clinical significance of the shadows or altered physical signs. Naturally such a state of affairs could not exist. The American Sanatorium Association, realizing that many non-tuberculous cases were being treated in tuberculosis sanatoriums required that the degree of activity as shown by the symptoms be included with the clinical and roentgen diagnosis. This excellent move had the beneficent effect of creating vacancies for real cases of tuberculosis in institutions which until that time had treated chiefly anatomical lesions. It further had a wholesome effect on both clinicians and roentgenologists who were too eager to be the first to discover the lesion. Under the stimulus of this move, and from an increasing knowledge of what constituted the upper limit of normal in roentgenographic shadows in the chest, the roentgenologists rapidly retired from the field of battle and went back to the excellent ground work of Cole. We accepted the shadows described by him; the typical mottling of parenchymal tuberculosis as being the earliest roentgen sign of tuberculosis, and threw all else into the discard. We were serene for a time in that belief, and during that period probably more accurate than we have been before or since. Then Dunham began to be more and more insistent that he had discovered an earlier characteristic sign. We were loath to accept it for we had delved into the unknown before and paid dearly for it. His proofs, however, were so definite that they could no longer be ignored. Dunham's work would have met with wider acceptance more quickly but for the fact that most of us disregarded his technique and so failed to duplicate his results. By the time his technique and beliefs were generally accepted, influenza was upon us.

Having become thoroughly convinced that the smooth homogeneous infiltrations described by Dunham were produced by early clinical tuberculosis, and being further convinced that tuberculosis behaved in a fairly orthodox manner, the next few years were a nightmare for most of us.

I shudder when I think of the thousands of patients during this period on whom I made a diagnosis of pulmonary tuberculosis recent in origin. Following this period my belief that tuberculous and non-tuberculous pulmonary conditions could be accurately differentiated practically perished. I remember 3 cases in a single month, all with extensive consolidation and 2 of them with tubercle bacilli in their sputum, all returned from sanatoriums as non-tuberculous. Re-examination of them showed their lungs quite normal. The 2 sputum positive cases were, in all probability, slowly resolving influenzal pneumonias, the positive sputum being due probably to a ruptured caseous gland. The third case was, in all probability, an unresolved pneumonia.

With all my beliefs crumbling, I went to visit an old friend, an eminent specialist in lung diseases. I well remember his answer when I asked him what change, if any, his opinions had undergone regarding the diagnosis and prognosis in tuberculosis. He said, in effect: "Ten years ago I considered pulmonary tuberculosis one of the easiest of diseases to diagnose or exclude. I now think that it is often one of the most difficult since influenza has become prevalent. In sputum negative cases, often time alone will decide the question. These cases I watch for a few months. If there is no clearing up in the roentgenogram, they are probably tuberculous. If they do clear up, they are possibly not."

Unquestionably we are now seeing and recognizing more truly early tuberculosis than we ever have before. Conversely, I believe that the percentage of non-tuberculous lesions pronounced tuberculous is higher than it was ten years ago. During the past few years I have had the privilege of watching several hundred such doubtful cases. They showed smooth, irregularly rounded, or fan-shaped areas of infiltration in the outer quadrant of one, or occasion-

ally both upper lobes. A second set of plates made within four or six weeks invariably showed a change in the shadows. One of two things occurred. Either the shadow had grown noticeably fainter or entirely disappeared, or it had lost its smooth homogeneous appearance and broken up into typical conglomerate tubercles and in certain of the cases had undergone an extension in addition.

Several of these cases had tubercle bacilli in their sputum when first seen. These cases were usually unchanged at the end of four or six weeks. Some of them showed a slight extension; some a slight retrogression, and a few showed an entire disappearance of the lesion. After three or four months it was not unusual to have a complete disappearance of the lesion, particularly if the plates were examined without knowledge of the location of the pre-existing lesion.

A careful study of a large group of such cases is rarely possible in private practice and practically never possible in sanatoriums, in that they have usually undergone resolution by the time they have gained admission. A critical review of these cases after the end result has been determined has given no additional information as to how we may differentiate the tuberculous from the non-tuberculous, at the time of the first examination.

Sanatorium physicians have shown how the roentgen signs disappear or increase, even before the symptoms have indicated that such a change might be expected from the plates. One fact they have proven beyond a doubt. One can never determine the true status of a known tuberculous lesion in the lungs from a single set of plates. Serial plates over a period of a few months are necessary before a prognosis can be ventured. How much more necessary that we should assure ourselves of the tuberculous nature of the lesion before pronouncing it tuberculous. Granting that a high percentage of these early infiltrations are tuberculous, as has been proven by finding tubercle bacilli in the sputum of a number of them, a reservation of opinion for four or six weeks until a second set of plates is made and the extension, resolution or change in appearance of the shadow is determined will result in no harm to the patient, granting he has been treated as a suspect in the meanwhile. The internist and general practitioner have placed a heavy responsibility upon the shoulders of the roentgenologist. I feel that we have borne that responsibility and proven beyond a reasonable doubt the value of negative plates in excluding clinical tuberculosis.

Conversely, our duty is just as great in not pronouncing non-tuberculous lesions tuberculous. Certainly our reputation for accuracy is not helped when the patient is pronounced non-tuberculous upon his entrance to a sanatorium a few weeks after a positive diagnosis from us. I have known hundreds of such patients denied employment, marriage and life insurance solely because they once had a diagnosis of tuberculosis, based entirely upon questionable roentgen findings.

In addition to the above described cases of questionable tuberculosis we have through the dispensary service of the University had the privilege of following with yearly roentgenograms many patients upon whom therapeutic abortions had been performed because of extensive tuberculosis. Many of these lesions have undergone almost complete resolution and the patients after several years have passed safely through childbirth. The lesson we have derived from a study of these cases is that while the indications for a therapeutic abortion can often be seen on a single set of plates, artificial sterilization should not be advised until it can be seen how well the lesion will clear up under treatment.

SUMMARY

1. The earliest roentgen sign which can be definitely diagnosed as tuberculosis is the typical mottling first described by Cole.

2. Pulmonary tuberculosis can be detected at an earlier stage, but the shadows are not pathognomonic.

3. Remarkable resolution, even to complete disappearance of a tuberculous lesion can take place in a very few months.

4. While the indications for therapeutic abortion can often be seen on a single set

of chest plates, artificial sterilization should never be advised until a period of observation has determined that the lesion will not undergo resolution.

DISCUSSION

DR. J. BURNS AMBERSON, Detroit, Mich. I regard Dr. Bissell's discussion of the fundamentals of roentgen diagnosis of tuberculosis as very sound. I think it may be of interest to you if I could read a few paragraphs here showing the change in point of view that has occurred among tuberculosis men regarding the value of the roentgen ray. I have here a pamphlet, "Diagnostic Standards of the National Tuberculosis Association," published in 1922. At that time, included among the minimum standards for the diagnosis of pulmonary tuberculosis, was this statement: "X-ray evidence of apical infiltration may be of importance."

We had a meeting of a committee last December to revise this pamphlet and it will be published within a few weeks perhaps and distributed widely through the country. I would have you note the change in point of view that has occurred: "It is now recognized that the proper taking of X-rays, preferably stereoscopic, is an essential procedure in examination of the chest." And under roentgenographic findings, "Definite parenchymal changes are seen in nearly all instances of proved pulmonary tuberculosis. Absence of such changes demands other proof of the existence of the disease."

I think that speaks for itself without any further discussion.

Dr. Allison's paper is on a subject in which I have been particularly interested. The changes which he illustrated here are uniquely the revelation of roentgen investigation. We were never able to appreciate them by clinical examination alone; there are several reasons for this which I think should be borne in mind when the roentgen findings are to be correlated with clinical evidence. One is that, in spite of the resolution of these deposits as shown by the roentgen ray, typical râles may persist over the site of the lesion for a good many years. The clinician naturally was prone to think that if râles persist the lesion persists, but apparently this is not entirely so, at least so far as we can demonstrate by the roentgen ray. It is possible that in some of these locations of marked resolution miliary tubercles may persist which are not visible on the roentgen film. Nevertheless the patient gets well and is able to work and he often continues well, although râles may be elicited in his lung for years and years, perhaps the remainder of his life.

This process of resolution was recognized quite well at other points in the body long ago. We all know of the resolution of tubercles in peritoneum or in the larynx, so that there is evidence that this type of lesion, the exudative type, is not uniformly of bad prognosis but may undergo absorption. Coincident with the clearing of the pulmonary lesion there is an increase in vital capacity of the lungs which is practically proportionate to the extent of the resolution. In other words, there is not only an anatomical clearing but there is also a proportionate restitution of lung function. As a rule, some demonstrable tubercles do persist despite extensive resolution, but they often become encapsulated and clinically may not be of significance.

In this connection I should like to call your attention to a peculiarly striking resolution of pulmonary lesions in children. In France this type of lesion, approximating a consolidation, has been called splenopneumonia. The Germans have spoken of it as epituberculous infiltration. There may be a partial consolidation of a lobe or even of an entire lung which later clears most remarkably. In all these cases, as also in most of the adults, small residual tubercles do persist; and following such clearing, one of the German workers, by the injection subcutaneously of tuberculin, has been able to cause recurrence of this tremendous inflammatory reaction about the central tubercle, giving again the signs of consolidation. The roentgen shadow, therefore, is dependent largely on an inflammatory reaction about the central tubercles which may be few and which may persist even though the collateral inflammation does resolve.

DR. BISSELL, closing. If I may have the privilege, I should like to discuss one or two points in Dr. Allison's paper, because it is very interesting. First, the question of differentiation between tuberculosis and the changes which we see as a result of influenza. It seems to me there ought to be very little confusion. There may be some cases in which the changes due to influenza may mask tuberculous changes making it impossible to render a negative diagnosis as to tuberculosis, but rarely is there sufficient evidence upon which to make a positive diagnosis of tuberculosis in these cases. It seems to me that the essential differential point is that tuberculosis begins in the periphery of the lung or well out in the parenchyma, whereas the infiltration due to streptococcus infections tend to spread into the periphery. I am sorry that Dr. Selby, who is here, did not discuss that phase of this paper.

During the war, he studied at Walter Reed Hospital a large series of these influenza cases, and it seemed to me in looking over those films with him, that we could observe evidence of the extension of this process outward from the hilus. I believe this type of infection may usually be traced from the mediastinum outward, so that differentiation ought not to be difficult.

DR. ALLISON, closing. In regard to Dr. Bissell's statement that these post-influenzal pneumonias should be easily differentiated from tuberculosis, I think that is so in the vast majority of the cases, but I tried to make very clear that the lesions I described are in the outer quadrant of one or both upper lobes, the location where early tuberculosis is found in practically 95 per cent of the cases.

I realize perfectly well that the basal lesions are usually pneumonias and that the upper lobe lesions are in the vast majority of cases tuberculous, but I want to go distinctly on record as saying that these cases are in the outer quadrant of one or both upper lobes.

As regards the question, in cases with hemoptysis, of how much of this lesion we see is blood and how much is an exudative type of tuberculosis I am unable to say. A rapid spread of apparently an exudative type of tuberculosis occurs quite often just after a rather large pulmonary hemorrhage and the lesions clear up as the usual rule quicker than an exudative tuberculosis will clear up.

I am very appreciative of Dr. Amberson's discussion of our papers.

DISEASES OF THE CHEST DEMONSTRATED BY LIPIODOL*

BY A. HOWARD PIRIE, M.D.

MONTREAL, CANADA

LIPIODOL is a clear, pale yellow, heavy oil. It contains 40 per cent iodine in chemical combination with oil of poppy. It is so heavy that a drop of it sinks in water as quickly as a small stone. If it is allowed to spread on the surface it floats. In the body it acts similarly, that is, it disseminates itself as an oil in the alveoli of the lung, but a drop of lipiodol entering a cavity containing pus or fluid sinks to the bottom of that cavity and remains as a round globule. It is not a new preparation but has been in use for more than twenty-five years as a medicament for intramuscular injection, when long-continued iodine treatment was desired. It takes from two months to two years for the iodine to be absorbed. In the lung it does not remain so long a time as it is partly expectorated, but I have seen it remain for sixty-five days. It causes little inconvenience when injected into the bronchi. I spent a day and night with a volunteer who had had this injection. During that time he did not cough and when I left him he felt as if nothing had been done to him. We have injected 50 c.c. of lipiodol with no bad effects. The whole quantity must run downhill from the end of the syringe so that even if the posterior half of both lungs were completely filled the patient would have the anterior half to breathe with and be in no danger of suffocating.

We have made seventy-seven injections of lipiodol into the lungs and have seen no bad effects in any of our cases except in one advanced case of bilateral tuberculosis with pneumonia who was unwisely subjected to the injection. A roentgenogram of his chest was made immediately before the injection and it showed a small heart. During the injection his heart failed and restoratives were ineffectual. After efforts lasting half an hour another roentgenogram was made which showed that the heart had dilated to about twice its former size showing that he had died of acute dilatation of the heart. Landau has used iodine 51 g. per c.c. in oil of sesame and found it as good as lipiodol in 18 patients. Fores-

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tier recommends the indirect injection by a curved cannula and the cricothyroid puncture. I have had no experience with this method since we have used direct bronchoscopy in all of our cases. In skilled hands this method has many advantages as the bronchioles can be emptied to a certain degree before injecting the lipiodol. Also the exact part of the lung to be examined can be injected and the rest of the lung left free. The bronchoscopic examination by itself is a great advantage for ascertaining the condition of the trachea and larger bronchi. The injection used in all our cases has been carried out by Dr. David Ballon at the Royal Victoria Hospital.

The patient may or may not receive a hypodermic injection of morphine half an hour before anesthetizing the larynx with a 20 per cent solution of cocaine one part and adrenalin 1/1000 two parts. The patient then lies on his back and the bronchoscope is placed in position. The larynx, trachea and bronchi are examined. Before pushing the bronchoscope beyond the larynx, the trachea and bronchi are sprayed with the same solution to abolish coughing. Pus and secretion are thoroughly aspirated and then 10 to 40 c.c. of warm lipiodol are injected with a long Lukens bronchoscopic syringe. It is thus possible to inject any lobe of the lung but it must be remembered that the lipiodol is a heavy oil and will run down hill only, so that the lung posterior to the end of the syringe is the only part which receives the lipiodol. It is for this reason that it is safe to inject such a large quantity. Some roentgenograms give an appearance as if nearly the whole of the lungs contained lipiodol but it is really only the posterior parts that are injected when the patient lies on his back.

As soon as the bronchoscope is withdrawn a roentgenogram is made with the patient still supine. A lateral view is then made with the patient lying supine. We have made views in many other positions but these two have proved to be the most useful. Once the oil has lined the interior of the alveoli it cannot be easily displaced. For instance, when a normal right lower lobe is injected with the patient on his back, the lipiodol will remain in the posterior part of the lung when the patient lies on his face. A trace may be seen, however, in the bronchioles towards the front but none in the alveoli as too little leaves the posterior aspect for it to reach the alveoli of the front. The movement of the lung during respiration can then be studied with the roentgenoscope. On coughing the lipiodol remains in the alveoli and little or no change in its position can be noted. If, however, the lipiodol remains in

FIG. 1. Lipiodol injected with patient supine, showing the lipiodol in the posterior half of the chest. This roentgenogram was taken with the patient prone and the rays horizontal showing how the lipiodol remains where it is injected and does not spread by gravity to the front.

the bronchi the act of coughing may scatter it over the whole lungs. The lipiodol can be seen on the screen to move with the beat of the heart and for this reason a flash exposure must be made to get a sharp picture.

The amount of movement of the lipiodol caused by the heart depends on the distance of the lipiodol from the heart. If it is near it moves, if it is far away the movement is not seen. Thus in roentgenoscoping, some lipiodol is stationary and some beats with the heart.

FIG. 2. A case of bronchiectasis showing how lipiodol leaves the lungs. The disease is present at the base of the right lung. Roentgenogram taken immediately after the injection.

FIG. 3. Same as Figure 2, taken one hour later.

Elimination of the lipiodol takes place first by coughing, thus clearing the bronchi and bronchioles, but the alveoli retain the lipiodol for days or weeks. I have seen it present for more than two months after injection. As it is disappearing it gives an appearance very like advanced tuberculosis. Its position, however, is not that of tuberculosis. I have been deceived by it and given a report of tuberculosis till I found that lipiodol had been injected a month previously.

Bronchiectasis is not easily diagnosed clinically or roentgenologically. It is therefore fortunate that lipiodol gives an absolutely characteristic picture of this disease. The dilated bronchioles become filled up in their proximal parts. The lipiodol does not reach their terminal parts probably because they are already full. The result is that the lipiodol stops short in a dilated bronchiole giving a club-shaped end, or it may be convex or pointed depending on the shape of the space into which it flows. The picture of bronchiectasis, as demonstrated with lipiodol, is so characteristic that when once seen it is easily recognized again. Bronchiectasis overlapped by the shadow of the heart is especially uncharacteristic in the roentgenogram unless lipiodol is used, but with its use the disease is easily made evident.

A case of bronchiectasis immediately after injection of lipiodol may present an appearance like a bunch of grapes. Other cases give an appearance of branching short rods with club-shaped ends or pointed ends. As the lipiodol disappears after a few days the proximal parts of the rods disappear and drops of lipiodol remain in the dilated bronchioles until the last drop disappears in about two months. Even then some lipiodol may be seen in the alveoli.

Lung Abscess. Lipiodol will not enter an abscess except under certain circumstances. Some of these are as follows:

If the abscess is toward the front of the chest and the injection is made with the

patient supine the lipiodol will flow towards the back and will not run uphill to the front. If the abscess does not communicate with a bronchus or bronchiole the lipiodol will not enter it. If the abscess is already quite full of pus no lipiodol will enter it unless its opening into the bronchus is large. Lipiodol, although much heavier than pus, will not flow through an opening smaller than about 3 mm. This is well seen in bronchiectasis where the lipiodol stops short in the bronchioles and does not reach the alveoli.

Sharpe and Peterson have lately reported that after injection of lipiodol into the spinal canal the lipiodol was found later encapsulated in adhesions. On the other hand, in our own experience injection of lipiodol into the lungs has been followed by complete disappearance of the drug in two months or less. We are inclined to think it has a beneficial therapeutic effect rather than the reverse.

We injected lipiodol in one case of miliary tuberculosis but got no further information.

FIG. 4. Taken two hours later than Figure 2.

FIG. 5. Taken twenty-four hours later than Figure 2.

Lung abscess and new growth have, in our experience, been indicated by lipiodol by negative rather than by positive evidence; that is to say, the lipiodol avoided the area of abscess or tumor and entered the surrounding lung.

Cavities due to tuberculosis being empty and freely communicating with the bronchi are easily injected with lipiodol, but this is an unnecessary use to make of lipiodol as they can be diagnosed without it. We have injected cases of tuberculous cavities without any untoward result. Cottenot, however, has reported this year that in 4 cases of progressive tuberculosis of the lungs, exacerbation followed and 2 died after use of lipiodol. He concludes that lipiodol should not be used in progressive tuberculosis.

While mentioning dangers of lipiodol, Stenosis of the trachea and bronchi can be shown by lipiodol. Stenosis should be looked for as a sign of new growth. The physical conditions of capillarity and gravity must be kept in mind before diagnosing stenosis. The descent of lipiodol down the bronchioles can be imitated with a glass tube. If a glass tube is made tapering to a fine point and closed at the point and filled with water to represent a bronchiectatic bronchiole full of pus or secretion and lipiodol is poured down it, the drug sinks through the water till it reaches a lumen inside the tube of about 3 mm. and there it stops with a convex lower margin. Thus in bronchiectasis where the bronchioles are full of secretion the lipiodol stops short and does not reach the termination of the bronchiole.

After thoracoplasty we have demon-

strated large bronchiectatic dilatations which when filled with lipiodol look like abscesses. One such was considerably larger than a hen's egg. When roentgenographed before injection no trace of this dilatation was visible. One gets so little information from roentgen examination in a case of thoracoplasty due to the dense appearance of the collapsed lung along with thickened pleura, that lipiodol in showing the bronchiectasis and cavities present is a valuable aid for devising improvement in technique in the operation of thoracoplasty. It also helps with a prognosis. More complete rib removal in thoracoplasty seems to be indicated from the roentgen appearance as so often uncollapsed lung is visible. When a large cavity is demonstrated after thoracoplasty it might be advisable to operate and collapse the lung further.

FIG. 6. Taken seven days after Figure 2.

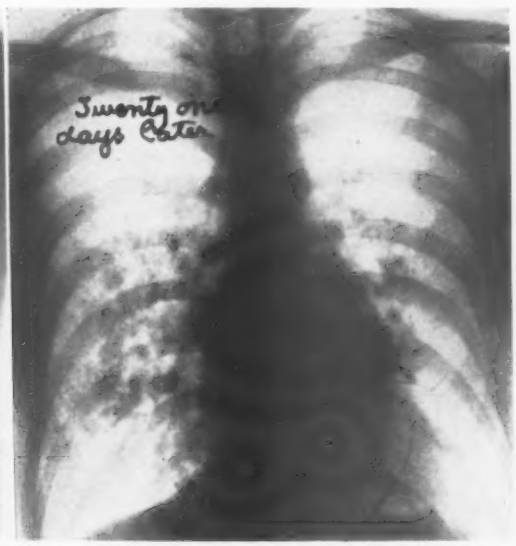

FIG. 7. Taken twenty-one days later than Figure 2. The alveoli hold the lipiodol longest. After a month the appearance is like tuberculosis.

CONCLUSIONS

Roentgen examination after the injection of lipiodol gives a pathognomonic picture in bronchiectasis; 50 c.c. have been injected with the patient in supine position with no bad effect. The after-effects of thoracoplasty can best be studied by the use of lipiodol. In skilled hands bronchoscopic injection of lipiodol is the best method.

Indications for use of lipiodol are: Suspected bronchiectasis; suspected tuberculosis when tubercle bacilli cannot be found in sputum; after thoracoplasty, when the patient is not doing well; for demarcation of the diaphragm when the diaphragm is invisible in suspected subdiaphragmatic abscess; for exclusion of bronchiectasis before performing thoracoplasty; for localization of a known abscess; for stenosis; for demonstration of a tuberculous cavity; for bronchopleural fistula; for foreign bodies, and for the negative diagnosis of bronchiectasis.

ABSTRACT OF DISCUSSION

DR. STEWART (New York) emphasized very strongly the importance of marking the lipiodol injections under bronchoscopic control. There should be a spiral on the end of the bronchoscope which is inserted into any bronchus from which pus is exuding, and the injection made directly into that bronchus. There is always edema around the mouth of the involved bronchus or bronchi and it is only by the use of the bronchoscope that filling of the involved area can be assured. Dr. Stewart said that he had found the use of two fluoroscopic outfits at right angles to each other as originally used by Dr. Manges of great use in guiding the bronchoscopist in injecting the proper amount of lipiodol. It is important not to inject too much since it may fill the alveoli so that they overlap each other

and simulate the appearance of cavity when there is none present. His experience indicated that 5 c.c. is enough for any one bronchus.

DR. ADOLPH HARTUNG (Chicago) stated that he had been working with Dr. Hedblom who uses the subglottic method. With the patient in a sitting position the neck is anesthetized, incision made and the injection performed with the patient sitting. The body is rotated to the side on which the pathology is thought to be located and films are made in the upright and oblique positions. He stated that they had had quite a number of cases with very satisfactory results by this method.

DR. CHARLES WATERS (Baltimore) asked about the toxicity of the drug. He stated that work formerly reported by Drs. Rowntree, Jones and himself upon the intravenous injection of iodoform in oil had shown that iodine is excreted through the kidneys in such quantities as to produce fatal nephritis in dogs. He cited work in which it had been stated that red blood cells and albumin were found in the urine after injection of lipiodol.

DR. H. K. PANCOAST (Philadelphia) said that it is not difficult to withdraw the lipiodol after examination if the bronchoscopic method described by Dr. Stewart is used.

He emphasized Dr. Pirie's statement that lipiodol may adhere to the alveoli after it has worked its way into them and give an appearance of a new lesion beyond the real area of pathology. He also emphasized the importance of not injecting too much lipiodol which may result in production of shadows simulating cavities.

DR. PIRIE, in closing, stated that he thought 5 c.c. as recommended by Dr. Stewart an insufficient amount. In reply to Dr. Waters he said that they had found a little iodine in the urine in some cases but no blood nor any other evidences of toxicity.

The danger of mistaking areas in which lipiodol remains for some time for areas of tuberculous infiltration he said could be overcome by attention to the history and to the following points: the lipiodol is seen nearer to the mediastinal portion of the lungs rather than in the peripheral portions; it is especially absent from the upper portion of the lungs where we expect to see tuberculous infiltrations.

THE MEASUREMENT OF THE LIVER BY MEANS OF ROENTGEN RAYS BASED UPON A STUDY OF 502 SUBJECTS*

BY G. E. PFAHLER, M.D.

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THE importance of determining the size, outline, and position of the liver is indicated by the fact that in every physical examination of a patient, the physician tries to determine these factors by palpation and percussion. The variation in the size of the liver has a very important bearing upon diagnosis, especially in diseases of the chest and the abdomen. Just as the teleroentgenogram has been found more accurate in outlining the heart than percussion, so I am sure that the Potter-Bucky diaphragm technique will permit a more accurate outline of the liver than can be determined by any other means. If it is important to determine the outline of the liver at all, it is important to determine it accurately.

For many years in my routine reports upon gastrointestinal studies, I have called attention to any gross enlargement of the liver. My judgment on these enlargements was based entirely upon my personal experience, and the general impression of the relative size as compared with what I believed to be normal, just as one makes the observation that a certain man has a large nose without knowing accurately how large any man's nose should be.

No accurate roentgenological measurements seem to have been made previously to indicate what measurements may be accepted as standard or what may be considered even relatively normal. Therefore, with the hope of determining the practical value of such measurements and with the

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hope of establishing at least a relatively normal standard, I have been making routine measurements in every abdominal examination in my private laboratory, and have had made at two of the hospitals (Medico-Chirurgical and the Polyclinic Hospitals, of the Post-Graduate Medical School of the University of Pennsylvania) with which I am connected, 324 similar examinations upon subjects who are in general good health, but who came to our clinics because of some minor accident such as a broken wrist, or ankle, etc. From this group I believed I could obtain a more accurate estimate of the normal for various ages, height, weight, and thickness than could be obtained from a study of any group of students or nurses who would be likely to show much less variation.

Fig. 1. Normal liver. No abdominal symptoms.

For the technical work on these normal subjects I am indebted to the technicians, Miss Confer and Miss Gillespie, and especially to Dr. Jacob Cohen, one of our post-graduate students who made a record for me of 276 subjects.

TECHNIQUE

For these measurements the subject is placed in the supine posture upon a Potter-Bucky diaphragm. A 14″ × 17″ film in a double screen cassette is placed crosswise so that the lower border will include about 1 inch of the upper border of the crest of the ilium. This will, in practically all instances, include the entire liver, both kidneys, and the spleen.

The tube is centered over the ensiform cartilage, at a target film distance of 25 inches. It must be admitted that at this distance there will be some inaccuracy due to exaggeration according to the thickness of the patient but one is surprised at the slight difference that this makes in the figures. A slight allowance will have to be made, therefore, in a very thick patient.

Fig. 2. Carcinoma of the liver showing enormous enlargement.

Fig. 3. Liver showing moderate enlargement in gall-bladder disease. Note that the enlargement is upward and would not be detected by any physical signs.

Only the right lobe is usually clearly demonstrable, but since the enlargement in this lobe enters chiefly into a diagnosis, the determination of its size will be most important.

Two measurements of the liver shadow are taken; one is the "length" which is measured from the highest point of the upper border to the lowest border of the tip of the right lobe; the second measurement is the "thickness" which is measured from the upper border to the lower border in an oblique direction—in a direction that would be considered the thickness if one were to lay the lower border on a horizontal plane.

With regard to the patient we record the sex, age, height, weight, and the abdominal thickness. The thickness of the abdomen is measured on a level with the ensiform cartilage.

This report includes a study of 502 subjects; 324 of these I have classed as normal with regard to the liver, since their symptoms indicated no pathological condition that could be expected to affect the liver. We will analyze them, therefore, with regard to sex, age, height, weight, and abdominal thickness. In 324 healthy subjects studied, the average length of the shadow of the right lobe of the liver was found to be 21.3 cm. and the average thickness was 12.8 cm.

Sex. The average length of the shadow of the liver in adult females was 21.2 cm. and the average thickness was 12.9 cm. In males, the average length was 21.4 cm. and the thickness 12.8 cm. There is, therefore, no appreciable difference in the normal as affected by sex.

Age. Under this heading, I have made a classification in decades from twenty to seventy years of age. There were only a few normal subjects below twenty or above seventy years.

MEASUREMENTS ACCORDING TO AGE

Age, Years	Liver Length, Cm.	Liver Thickness, Cm.
20–30	21.1	12.6
30–40	21.3	12.8
40–50	22.1	12.8
50–60	21.2	12.1
60–70	21.1	12.7

It will be seen, therefore, that during adult life, age in itself has no appreciable influence upon the size of the shadows of the liver.

Height. The effect of height was studied by comparing the measurements in the normal subjects by inches from 5 feet to 6 feet.

MEASUREMENTS ACCORDING TO HEIGHT

Height	Length, Cm.	Thickness, Cm.
5 feet 1 inch	20.4	12.8
5 feet 2 inches	20.1	12.4
5 feet 3 inches	21.4	12.5
5 feet 4 inches	22.3	12.3
5 feet 5 inches	20.8	12.4
5 feet 6 inches	20.5	12.7
5 feet 7 inches	21.1	12.6
5 feet 8 inches	21.8	13.8
5 feet 9 inches	21.5	12.7
5 feet 10 inches	21.2	12.6
5 feet 11 inches	22.3	13.1
6 feet 0 inches	22.0	12.0

It will be seen that the height in normal adults influences the size of the liver slightly in length but not more than 2 cm., and not at all in thickness.

Weight. The effect of weight has been considered in gradations of ten pounds, from ninety to two hundred.

MEASUREMENTS ACCORDING TO WEIGHT

Weight, Lb.	Liver Length, Cm.	Liver Thickness, Cm.
90–100	20.7	12.3
100–110	20.6	12.4
110–120	20.3	12.6
120–130	21.1	12.4
130–140	21.1	12.3
140–150	20.8	11.8
150–160	21.5	12.4
160–170	21.4	12.7
170–180	21.7	12.4
180–190	22.4	14.4
190–225	22.7	15.0

It will be seen that weight has a little influence on the size of the liver, especially above 150 pounds. There is more increase above the weight of 190 than below. This group above 190 are doubtfully normal, though they seemed to be healthy and had no complaints.

Thickness of the Body. The thickness of the body as measured on a level with the ensiform cartilage was studied in gradations of 5 cm.

Thickness of Body, Cm.	Length, Cm.	Thickness, Cm.
15–20	20.4	12.4
20–25	21.2	10.2
25–30	21.1	14.0

It can be seen that the thickness of the body does not cause much variation as compared with the general average.

As one views these figures as a whole one is impressed with the slight variation in the size of the liver in normal, or rather healthy subjects. It is true that a very thick patient will give some increased

TABLE I

SERIAL RECORD OF THE STUDY OF SUBJECTS SUPPOSEDLY NORMAL

No.	Sex	Date	Age, Years	Weight, Lb.	Height	Body Thickness, Cm.	Liver Length, Cm.	Liver Thickness, Cm.	Remarks
47	Male	4- 5-26	42	144	5′ 4¼″	21	17.5	9.7	Normal
48	Male	3-18-26	54	180	5′ 9¼″	23.8	15.9	8.9	Cirrhosis of liver
49	Female	3-18-26	37	190	5′ 1″	30.5	22.0	15.0	Normal obese
50	Male	3-17-26	33	152	5′ 4¼″	20.5	21.2	11.5	Normal
51	Male	3-17-26	37	136	5′ 3½″	23.3	20.5	11.1	Normal
52	Male	3-15-26	41	137	5′ 5″	21.5	21.1	12.2	Normal
53	Male	3-15-26	26	158	5′ 2″	22.8	21.3	12.4	Normal
54	Male	3-15-26	57	160	5′ 4″	23.2	20.4	11.7	Normal
55	Female	3-15-26	53	133	5′ 7″	21.0	20.2	13.4	Normal
56	Male	3-15-26	71	125	5′ 5½″	21.0	20.0	12.3	Normal
57	Male	3-15-26	27	137	5′ 3″	20.7	23.1	12.7	Normal
58	Female	3-15-26	27	140	5′ 4′	21.6	22.2	12.0	Normal
59	Female	3-16-26	36	153	5′ 3½″	21.8	22.4	11.4	Normal
60	Male	3-16-26	32	150	5′ 7″	21.8	20.6	13.7	Normal
61	Male	3-17-26	35	141	5′ 10″	23.0	21.5	13.1	Normal
62	Male	3-16-26	21	140	5′ 9″	19.6	21.0	13.7	Normal
63	Male	3-16-26	40	127	5′ 5½″	17.0	19.4	9.3	Normal
64	Male	3-16-26	42	145	5′ 9″	23.5	20.8	11.5	Normal
65	Male	3-15-26	26	140	5′ 10″	24	22.5	11.5	Normal
66	Female	3-15-26	6½	42	3′ 8″	12.5	14.8	9.1	Normal
67	Male	3-15-26	31	128	5′ 6½″	20.0	18.0	12.9	Normal
68	Female	3-18-26	43	153	5′ 3½″	20.7	19.2	12.3	Normal
69	Male	3-18-26	58	160	5′ 10″	23.6	18.7	11	Normal
70	Female	3-19-26	36	160	5′ 3″	17.2	19.7	13.0	Normal
71	Female	3-19-26	28	120	5′ 6′	19.2	19.9	12.4	Normal
72	Female	3-18-26	30	110	5′ 0″	17.6	19.2	15.6	Normal
73	Male	3-18-26	34	143	5′ 8″	23.0	22.4	15.8	Normal
74	Male	3-18-26	40	160	5′ 5″	17.5	19.1	10.5	Normal
75	Male	3-18-26	46	165	6′ 0″	20.0	18.5	13.6	Normal

shadow due to exaggeration because of the nearness of the top surface of the liver in a 25 in. focal plate distance, but when one compares this general average of liver measurements in patients of 15 to 20 cm. body thickness with those of 25 to 30 cm. we find an increase of only 1 cm. in length and 2 cm. in thickness. It then becomes clear that one can utilize the general average for comparison with the abnormal. While neither sex, age, weight, height, or body thickness individually affects the size of the liver, it is true that a big patient has a larger liver than a little one, using the term "big" and "little" in the general sense.

It is entirely practical, therefore, to consider the average normal length of the liver shadow as 21.3 cm. with the normal limits of approximately 18 to 22 cm., and the average thickness 12.8 cm., with the normal limits of approximately 10 to 14 cm. When the measurements extend beyond these normal figures, an explanation should be found. A large patient may go above, and a small patient may go below. I have appended two tables of normal records, (Tables I and II), and one made from patients with abdominal symptoms (Table III), recorded in the order in which they were taken, so that the reader may see the variations as they occur.

In a review of these records of patients with abdominal symptoms, we at once see that many conditions are associated with enlarged liver. Slight enlargement is found in connection with intestinal stasis, as one would expect. In many cases, there is also enlargement associated with gall-bladder disease. The greatest enlargements have been found associated with cardiac disease, blood diseases and metastatic carcinoma. The various causes of enlargement of the liver have already been determined by clinicians and pathologists, but we have in our hands a far more accurate

TABLE II

STUDY OF SUBJECTS SUPPOSEDLY NORMAL

No.	Sex	Date	Age, Years	Weight, Lb.	Height	Body Thickness, Cm.	Liver Length, Cm.	Liver Thickness, Cm.	Remarks
105	Male	3- 9-26	19	140	5′ 4″	21.7	20.6	13.1	Normal
106	Female	3- 9-26	26	127	5′ 7″	23.0	20.1	12.7	Normal
107	Male	3-10-26	24	138	5′ 2″	27	20.1	12.9	Normal
108	Female	3-10-26	52	141	5′ 8″	20.4	19.5	11.8	Normal
109	Male	3- 8-26	44	214	6′ 0″	31.2	20.5	12.8	Normal
110	Female	3-10-26	44	192	5′ 11″	21.0	23.2	12.9	Normal
111	Male	3-10-26	26	128	5′ 3″	20.4	21.6	12.4	Normal
112	Male	3-10-26	37	225	5′ 11″	24	23.8	13.2	Normal
113	Female	3-10-26	38	180	5′ 9″	22.0	21.4	12.4	Normal
114	Male	3-10-26	47	171	5′ 7″	19.2	24.1	11.6	Normal
115	Male	3-10-26	66	140	5′ 2″	19.0	19.4	11.9	Normal
116	Male	3-10-26	55	145	5′ 5½″	23.1	22.0	13.0	Normal
117	Male	3-10-26	51	136	5′ 3″	20.2	20.6	11.7	Normal
118	Male	3- 4-26	53	165	5′ 7″	21.0	21.5	13.6	Normal
119	Female	2- 1-26	64	160	5′ 9″	21.0	20.2	16.7	Normal
120	Male	2- 1-26	60	152	5′ 4″	20.6	21.5	11.9	Normal
121	Male	2- 1-26	52	140	5′ 5″	20.4	21.7	14.1	Normal
122	Male	2- 1-26	45	129	5′ 7″	22.6	19.2	13.7	Normal
123	Female	2- 1-26	40	157	5′ 3″	19.8	20.5	10.2	Normal
124	Male	2- 1-26	52	160	5′ 4″	20.2	21.2	9.3	Normal
125	Male	2- 2-26	51	127	5′ 2″	20.0	20.7	12.4	Normal
126	Female	2- 2-26	58	162	5′ 2″	20.8	23.0	12.6	Normal
127	Female	2- 2-26	47	155	5′ 0″	21.3	22.5	13.1	Normal
128	Female	2- 2-26	40	140	5′ 7″	19.9	21.7	9.9	Normal
129	Female	2- 2-26	28	190	5′ 5″	32	23.5	14.8	Normal
130	Female	2- 2-26	21	127	5′ 9″	16.8	19.2	12.2	Normal
131	Male	2- 3-26	41	139	5′ 10″	19.7	22.2	12.3	Normal
132	Male	2- 2-26	38	133	5′ 3″	18.5	23.7	16.0	Normal
133	Male	2- 3-26	37	157	5′ 4″	20.0	24.0	16.6	Normal

means of making these measurements than ever before. If we make these records carefully, the relation to various diseases can be determined. I have seen a number of cases in which the enlargement was chiefly or entirely upward. Such enlargement cannot be determined by ordinary physical signs, and we may find in the future that such upward enlargement may have some special significance.

SUMMARY

1. An accurate record of the size and position of the liver can and should be made as a routine in every abdominal examination, by means of the Potter-Bucky diaphragm technique.

2. The average length of the right lobe of the liver is 21.3 cm., and the average thickness is 12.8 cm.

3. Sex, age, height, weight, and abdominal thickness individually make little difference in the size of the liver, but a large patient is likely to have a larger liver than a small subject.

4. The importance of determining the size of the liver has long been recognized, but with this more accurate means of measurement now available, it is likely that such information will be in greater demand.

DISCUSSION, ABRIDGED AND ABSTRACTED

DR. WILLIAM H. STEWART, New York City. I think we are indebted to Dr. Pfahler for some definite basis to work on on a liver enlargement. It has been quite customary, at least, with me, to say that the liver is a little large, and usually the physician or the surgeon who refers the case replies, "What do you mean by enlargement?" Having established some sort of normal in five or six hundred cases we can readily give the information that he desires. It is therefore constructive work.

Of course there is a chance for considerable error. I would like to ask Dr. Pfahler whether he placed very much importance on his hori-

TABLE III

STUDY OF SUBJECTS HAVING ABDOMINAL SYMPTOMS

No.	Sex	Date	Age, Years	Weight, Lb.	Height	Body Thickness, Cm.	Liver Length, Cm.	Liver Thickness, Cm.	Remarks
134	Male	2-3-26	52	136	5′ 6″	20.3	20.5	13.5	Normal
135	Male	2-3-26	47	159	5′ 7″	21.2	21.7	14.2	Normal
136	Female	2-3-26	51	170	5′ 4″	20.6	20.6	13.1	Normal
137	Male	2-3-26	40	181	5′ 6″	20.7	20.7	12.8	Normal
138	Male	2-2-26	29	160	5′ 10″	20.7	20.7	22.0	Normal
139	Male	2-2-26	19	152	5′ 5″	22.5	23.3	12.4	Normal
345	Male	11-5-25	59	183	5′ 7″	30	22	11	Gall stones (?)
346	Female	11-7-25	58	115½	5′	19	21	12	Intest. stasis
347	Male	11-10-25	51	183½	5′ 11″	26	24	14	Obs. L.L. ureter
348	Male	11-11-25	55	176	6′ 1″	30½	24	17	No abd. symp. spine
349	Female	11-12-25	37	104½	5′ 2½″	17	18	10	Kidney exam. intest.
350	Female	11-13-25	47	123	6′ 6″	20	25	14	Metas. ca. liver (?)
351	Female	11-13-25	49	136	5′ 1″	20	21	12	Post-op. ca. br.
352	Male	11-13-25	..	195	6′ 1¾″	21	24	15	Intest. stasis
353	Female	11-14-25	..	140	5′ 6¼″	16½	21	12	Healthy
354	Female	11-16-25	58	156	5′ 7¼″	30	22	14	Intest. stasis
355	Female	11-20-25	65	115	.....	20	20	14	Recurrent ca. br. 14 yrs.
356	Female	11-20-25	44	138	5′	27	33	17	Liver enlg.
357	Male	11-20-25	50	108	5′ 8″	23	29	15	Metas. ca. (spleen 19 cm. length)
358	Female	11-20-25	65	136	5′ 4″	22	21	12	Intest. stasis
359	Female	11-20-25	36	119	5′ ½″	20	20	11	Gall-bladder disease (?)
360	Female	11-21-25	34	117	5′ 3½″	16	21	12	Intest. stasis
361	Male	11-23-25	40	180	5′ 8¼″	21	24	15	Spinal curvature
362	Male	11-23-25	42	180	5′ 6¾″	22¾	23	16	Intest. stasis
363	Male	11-23-25	24	148	6′ 10″	20	26	14	Liver enlg. Duo. lesion. Gall-bladder dis. (?)

zontal line, because certainly there can be a source of error in stating whether the liver is markedly enlarged above or below that line; I mean relying on the opposite diaphragm to establish the level of the horizontal line.

In talking it over with Dr. Pfahler I mentioned that the line that he calls thickness is a little misleading. I believe that the term oblique measurement would more readily apply to it.

I should like to ask him if he has made any investigations as to the exaggeration of shadows with the patient lying on the back and lying on the abdomen. Measurements are made from the anterior surface of the liver and why not turn the patient on the abdomen and obtain a view with the abdomen as near the plate as possible, so as to do away with a possible exaggeration. I believe also that much better liver detail is obtained with the patient lying on the abdomen.

He spoke about work in the gall-bladder clinics. It is, of course, of great interest to note the difference in the liver shadow after the administration of tetraiodo. The liver shadow is much more clear, and regularity and size can be much more readily recognized after the administration of the dye than under ordinary conditions.

In a general way this establishment of a standard is of value. In certain things I still adhere to pneumoperitoneum.

Dr. Stewart stated that, contrary to the general opinion which seems to be prevalent, he still uses the pneumoperitoneum method in many cases. If a diagnosis can be arrived at by other means the method is not applicable but there are certain cases in which it gives information not obtainable otherwise.

DR. ALFRED L. GRAY, Richmond, Va. I want to express my appreciation to Dr. Pfahler for his work. I think it does fill in some very important data for the clinician. I want to ask Dr. Pfahler if he has done any measurements of the spleen and if he could in the publication of his tables embody also similar work on the spleen. We are so often called upon to ascertain whether the spleen is enlarged. If we could have some standard measurements of a normal spleen, we could determine deviation therefrom, and I think it would add very much to the completeness of his measurement of the abdominal viscera at least.

DR. R. R. NEWELL, San Francisco. I agree that we ought to pay some attention to the size of the largest gland in the body and the one with the most complex function, and I do agree that sizes of lesions and sizes of organs ought to be in centimeters and not in indefinite terms.

I am somewhat puzzled at the apparent failure to correlate the size of the liver with the size of the body. It seems to me that I am entitled to a liver twice as heavy as a man who is only half my size.

I would like to see Dr. Pfahler's normal material worked over by statistical methods. It might yield correlations that one doesn't suspect from a table of measurements.

DR. W. O. UPSON, Battle Creek, Mich. The subject of the measurement of the liver is of unusual interest. I would like to ask Dr. Pfahler why he prefers the posterior position for the patient. Is there any difficulty in outlining the liver in all cases? If there is, has he attempted to inject the colon with some powder that would be apt to show the lower border? Another question would be, have you made any estimates by the measurement of the volume of the liver as was done by Bardeen on the heart?

DR. E. D. MCCARTY, Tacoma, Wash., asked Dr. Pfahler if it would not be better to make the roentgenograms with the tube at a distance of 6 feet in order to compensate for the curve of the Potter-Bucky diaphragm and to eliminate distortion.

DR. PFAHLER, closing. I, of course, haven't solved all of these problems; I haven't attempted to. There will be errors found; there will be enlargements found that will not be recognized by the roentgen ray. If you take into account the long and short diameter, you will probably find some variation in one of those two, and I believe that if you will take account of these measurements, as I have done, you will find that it will connect up with disease and the clinician will get some value out of it. Much remains to be told in the future.

As to the exaggeration of the shadow due to the curve of the Potter-Bucky diaphragm, that curve was made because of the curve of the body; that was one reason, at least, for its being curved in that way, it fits the ordinary body curve. The point is that we have checked this up in all those conditions with the normal and you will see that the normal does not vary greatly, but only moderately, and I suspect that when we once get it checked up thoroughly it will vary even less, it will come nearer the average, and that, I think, is the important thing that we must keep in mind.

I did not measure the spleen. I think if you wanted to measure the spleen in this work, you would probably have to make your exposure a little less than when you are working with the liver, because the amount of exposure that will bring out the borders of the liver certainly is very apt to over-expose the normal spleen. If you have an enlarged spleen it will show, but gas about that region will rather overshadow it and the spleen was not shown routinely in these films; therefore, I ignored it.

I may be wrong, but I got the impression that we could do this more uniformly and conveniently if we allowed the patient to lie on his back, and it seems to work, as checked up by the control tables.

Was there any question I overlooked?

DR. CASE. Did you try doing it fluoroscopically?

DR. PFAHLER. No. Instead of making this a very special examination, my idea was that we ought to take note of this in our routine examinations, whether it be kidney, gastro-intestinal or gall-bladder studies, and if we do it in that way we will make it practical. For that reason this is not a special liver examination; therefore, I did not go to a greater distance in order to get less exaggeration. We are working under our routine, normal conditions, and my plea to you is to make a report on what you find under those normal working conditions without adding extra expense in your work, or extra labor.

Vol. XVI, No. 6

METASTASIS IN CARCINOMA OF THE PROSTATE, WITH REPORT OF A CASE SHOWING EARLY AND LATE CHANGES

BY JOHN SPROULL, M.D.

HAVERHILL, MASSACHUSETTS

A search of the literature of the last eight years reveals the fact that only three articles have appeared during that time dealing with metastasis in carcinoma of the prostate. Two of these deal entirely with therapy. The third, a most excellent one, deals with the statistics of the metastasis and their location, and also, to some extent, with the diagnosis, differential diagnosis from Paget's disease of the bones, and also with the treatment by roentgen rays and radium. I am much indebted to this article by Bumpus,[1] and I take the liberty of quoting his statistics.

FIG. 1. Taken January 13, 1924. Note the involvement of the right ilium shown by the general mottled appearance due to miliary metastasis extending all through it; also the increased density in the region of the right sacroiliac joint, involving both the ilium and sacrum at that point. There are a few miliary areas of decreased density in the descending ramus of the right pubic bone.

FIG. 2. Taken one month later than Figure 1. The miliary areas of decreased density surrounded by rings of increased density can now be well seen in the right ilium, the region of the right sacroiliac joint, the region of the right acetabulum and the descending ramus of the pubis.

Out of 228 patients with carcinoma of the prostate who were examined roentgenographically, 69 showed metastasis. There were 46 cases showing metastasis in the pelvis, 40 showed metsstasis in the spine, 8 in the lungs, 8 in the ribs, and 7 in the femurs. He very well remarks "that if the spine, the pelvis and the femurs are examined by the roentgen ray routinely in all cases of diseased prostate suspected of being malignant, a negligible number of cases of metastasis will remain undiscovered.

"It does not seem necessary to examine the chest as a routine procedure since metastasis to the lungs alone probably never occurs in these cases."

Bumpus also states that probably one-third of the patients with carcinoma of the prostate will be found to have metastasis in the bones and the great majority of these will be in the pelvis, the spine and the femurs.

Metastasis in carcinoma of the prostate is essentially a disease of bone destruction associated with new bone formation. It belongs to the type of malignant bone changes showing principally osteoblastic changes although the destructive process is well seen at times.

It seems that the destructive process

Fig. 3. Taken one month later than Figure 2 and two months later than Figure 1 with which it should be contrasted. The areas of destruction in the ilium are now larger in size. In the center of the left ilium may be seen four or five small areas of increased density evidently the first evidence of metastasis on the left side. All of the pathological changes have previously shown on the right side.

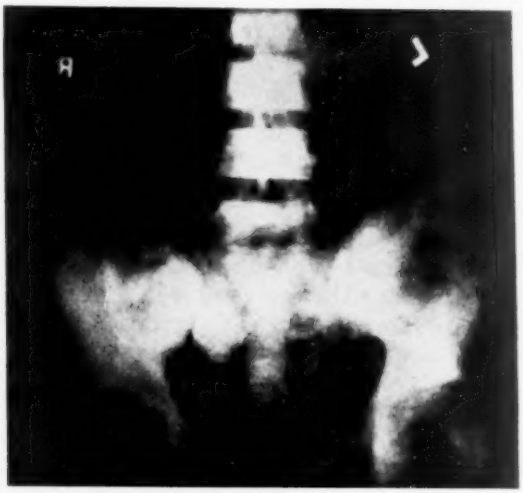

Fig. 4. Taken one year after Figure 3. Note the hyperplastic appearance of both ilia and also of the bodies of the lumbar spine. Some areas of decreased density surrounded by areas of increased density may be seen, but the whole general survey is that of increased density showing the osteoblastic type of bone change predominating. At this time the patient was confined to bed all the time and this film and all subsequent ones were taken with a small portable machine.

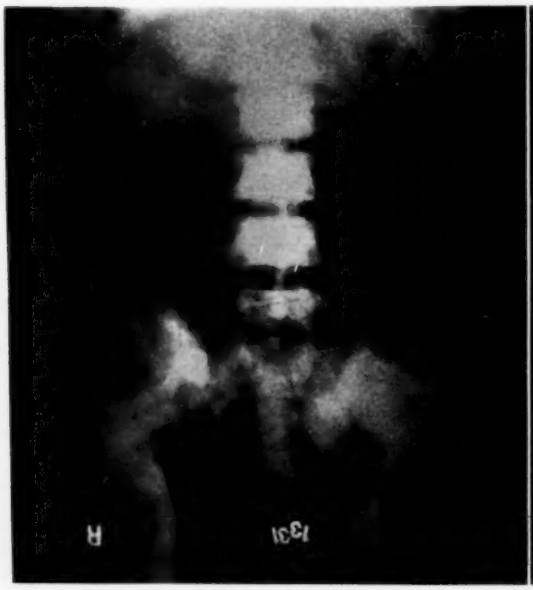

Fig. 5. Taken five months after Figure 4. All of the bones of the pelvis and the lumbar spine are involved. The processes of coincident osseous destruction and bone formation can be easily seen in the right ilium and throughout the sacrum. The upper extremities of both femurs were involved but do not show well in the reproduction.

Fig. 6. One week later than Figure 5. Shows same processes as Figure 5. Note the spur formation in the obturator foramen.

FIG. 7. The dorsal spine shows general almost uniform increase in density throughout. No areas of destruction could be made out. This was taken without a Potter-Bucky diaphragm, and possibly the better bone detail as the result of the use of a Bucky might have shown areas of destruction. The hyperplastic change in the bodies of the vertebrae is very suggestive of their involvement in the malignant process.

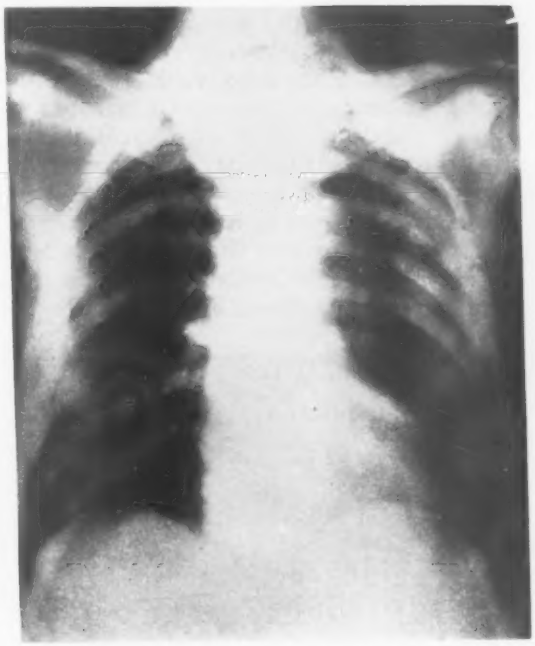

FIG. 8. There are many areas of typical metastasis to be seen in many of the ribs and it conforms to the characteristic type of coincident bone destruction and bone production.

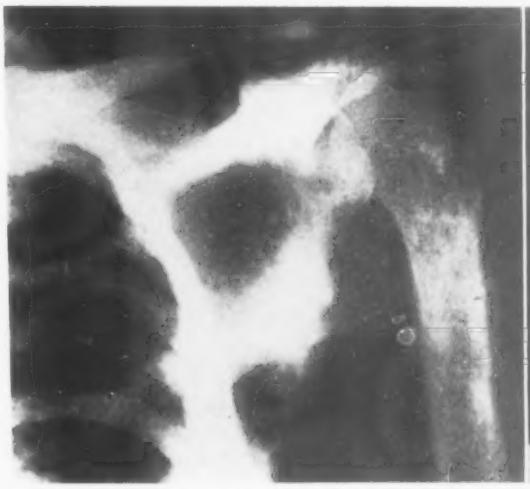

FIG. 9. Right shoulder girdle. Note the marked involvement of the clavicle, scapula, and upper end and upper two-thirds of shaft of the humerus.

FIG. 10. Left shoulder girdle. There is involvement of the left clavicle, scapula and upper end and upper two-thirds of the shaft of the left humerus.

proceeds at such a slow rate that nature has time to throw up a bulwark of defense in the form of markedly condensed new bone tissues. This results in the characteristic appearances, so well described by many writers, of areas of decreased density (bone destruction) surrounded by areas of increased density (bone production). However, it is not always easy to see macroscopically the area of bone destruction as the hyperplastic bone production seems at times to overshadow it, and the general macroscopic appearance, as shown in the accompanying illustrations, is largely that of bone condensation.

FIG. 11. Shows lower third of both humeri and upper two-thirds of both bones of both forearms. There is no evidence of metastasis in these bones.

No doubt on microscopic examination all cases would show the typical area of central destruction surrounded by the area of hyperplastic bone production. This hyperplastic bone production gives rise to the resemblance to Paget's disease of the bones and at times this disease may have to be differentiated.

However, Bumpus again points out that in Paget's disease affecting the spine, the bodies of the lumbar vertebrae are widened and flattened, while in malignant conditions there is little, if any, change in the shape of the vertebrae. Bumpus quotes Carman and Garrick,[2] who state that "if the skull shows the pathognomonic changes of Paget's disease, that is, thickening and density of the inner table and the finely porous outer table with scattered nodules of bone over the vault, the diagnosis of Paget's disease is certain."

So that in cases of doubt regarding the nature of the pathological process between metastasis from prostatic carcinoma and Paget's disease of the bones, the roentgen examination of the skull, if negative, would be a deciding factor in favor of metastasis from carcinoma of the prostate.

FIG. 12. FIG. 13.

FIG. 12. Shows bones of the lower third of the left forearm, the left carpus and hand. There is no evidence of metastasis in these bones.

FIG. 13. Bones of the lower third of the right forearm, right carpus and hand show no evidence of metastasis.

The following case is deemed worthy of reporting because opportunity was afforded to show by roentgen examination the early metastasis and to show by a later examination the extent and character of the metastasis just before the patient's death. The first roentgenograms were taken under excellent conditions with

all the facilities of a modern roentgen laboratory; the later ones were taken with a small portable apparatus in the patient's home, when the examination had to be more or less restricted on account of the sufferings of the patient.

FIG. 14. Lower two-thirds of both femurs and upper halves of both tibiae and fibulae show no evidence of metastasis.

CASE REPORT

F. W., male, aged forty-five. Chief complaint, backache in the region of the right ilium and right half of the sacrum of four months' duration.

For the past two months pain in the right groin and down the inside of the right thigh. Has had spells of frequent urination especially at night for the past six months, but has never noticed any dysuria or blood in his urine. He has not lost any weight.

A roentgen examination was made which showed the findings represented in Figure 1.

A subsequent complete physical examination failed to reveal any disease except in the prostate gland. Rectal examination with the finger revealed a very large, hard, nodular, irregular prostate.

The urine was clear, amber in color, acid in reaction, and showed no pus, blood or albumin. The patient said he had no difficulty in regard to urination other than a little increased frequency. The patient lived eighteen months after the time of the first examination, and during that time he became greatly emaciated, very anemic and developed complete paraplegia with complete sphincteric incontinence.

It is interesting to note that the early metastasis was confined to the right half of the pelvis.

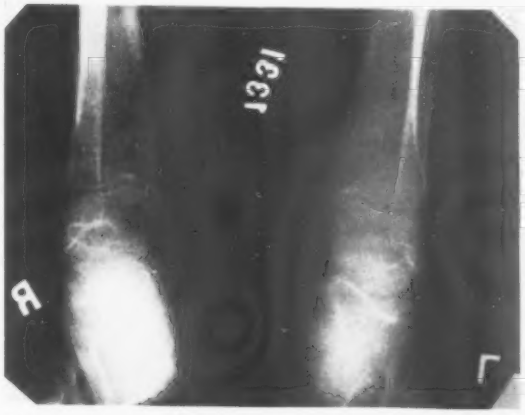

FIG. 15. Lower two-thirds of both tibiae and fibulae and bones of the tarsi show no evidence of metastasis. Note the extreme bone atrophy present in the femurs, tibiae and fibulae and tarsal bones.

At this time of roentgen examination the patient had been paraplegic for a long time. Contrasting the bones of the lower and upper extremities shows well the presence of extreme bone atrophy in the lower extremities and its absence in the bones of the upper extremities.

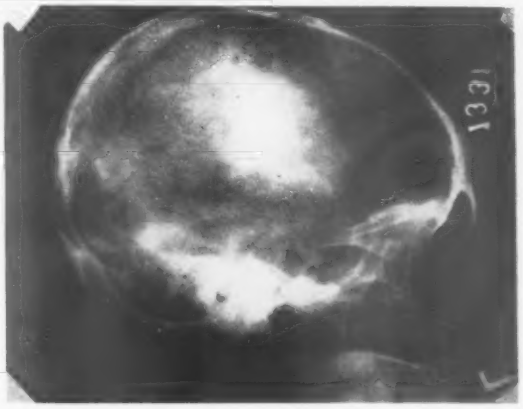

FIG. 16. Skull. No evidence of metastasis could be made out. Useful in differentiation from Paget's disease of the bones.

The late metastasis as shown by the illustrations involved: (1) all of the bones of the

pelvis; (2) the heads and upper parts of shafts of the femurs; (3) all of the bodies of the lumbar spine; (4) nearly all of the ribs; (5) both clavicles; (6) both scapulae; (7) the heads and upper halves of the shafts of both humeri, and (8) the dorsal spine showed uniform increase in density which was suggestive, but not absolutely characteristic of metastasis.

It is also interesting to note that no metastasis was present in the lower extremities below the upper third of the shafts of the femurs.

In the upper extremities no metastasis was present below the junction of the middle and lower thirds of the shafts of the humeri.

The bones of the cranium showed no evidence of metastasis.

A post mortem examination was requested but permission for even a partial post mortem was refused.

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EDITORIALS

ROENTGEN PLEUROPNEUMONITIS

IN 1921 attention was called to certain pleuropulmonary changes which were believed to have resulted from exposing the chest to roentgen rays for therapeutic purposes. Naturally and properly such a pronouncement was received with a certain degree of skepticism, but its confirmation was speedy and conclusive. Within two years it became generally accepted, and a good deal has since been added to our knowledge of the subject. Among the more noteworthy contributions are those of Desjardins, Davis, and Evans and Leucutia.

Desjardins was the first to call the condition roentgen pleuropneumonitis. His description of the symptoms and signs of the affection are lucid and accurate. Davis in his experiments on animals definitely established its specific nature, and has contributed essentially all that we know of its pathology. Evans and Leucutia have brought out many practical points as to the relationship of dosage to the incidence and permanency of the lesions.

The circumstantial evidence is strong that changes in the technique of treating carcinoma which came into vogue about 1920 are directly related to the occurrence of roentgen pleuropneumonitis. The chief factors which seem to be operative in its production are the exposure of large fields at a relatively long skin focus distance with a proportionate increase in the duration of the exposure. It is definitely known that extremely high voltages or very heavy filtration are not essential to the production of extensive pleuropulmonary changes. This would seem to negative the assumption that these are at all necessary for profoundly influencing deep seated structures, and indicates that our preconceived notion with respect to the superiority of high voltage apparatus in the treatment of deep seated malignancies may have been erroneous.

The occurrence of pleuropulmonary lesions due to roentgen rays, as well as their extent and permanence depend upon the dose delivered to these structures. A single dose of less than 100 per cent of a skin unit dose delivered over two or three large thoracic fields at a skin focus distance of 12 to 16 inches is not likely to cause any appreciable pleuropulmonary reaction, but if this dose is exceeded marked pleuropulmonary reactions may occur, especially if the chest and chest walls are thin. Skin tolerance cannot be taken as an absolute measure of lung tolerance. Permanent lung changes may result when the acute skin reaction has been transient. It is probably incorrect, however, to assume in such cases that the thoracic wall itself has escaped damage simply because it appears essentially normal on inspection. The writer has under observation two cases of pleuropulmonary fibrosis due to roentgen rays in which spontaneous fractures of several ribs occurred three and four years respectively after treatment. A consideration of all the facts with respect to these cases makes it appear reasonably certain that the rays led to an increased fragility of the bones which caused them to break under the stress incident to the retraction of the thoracic wall, the latter being a common sequence of roentgen pleuropneumonitis. This observation is of interest in connection with the experimental work of Phemister on the effect of radium implants on bone which was published in the October number of this Journal.

In view of the fact that most cases of roentgen pleuropneumonitis occur in patients who are being treated for mammary carcinoma, the impression has prevailed that it is exceedingly difficult to differentiate the roentgen reaction from pleuropulmonary metastases. This is ordi-

narily not the case unless there is pleural effusion or extensive metastases at the time of beginning treatment. To make the differentiation possible, however, it is absolutely essential that careful clinical records be kept, and that satisfactory roentgenograms of the chest be obtained prior to treatment and at frequent intervals thereafter.

No deaths from roentgen pleuropneumonitis have been reported, and the affection even when it has eventuated in the loss of function of an entire lung has not appeared to be markedly disabling. Notwithstanding these facts its potential gravity should be recognized.

The fact that roentgen rays are capable of producing marked structural changes, and alteration of function of internal organs, with relatively slight surface effects in no sense contraindicates their use as a therapeutic agent. On the contrary, it lends encouragement to their continued use, but emphasizes the necessity for caution. Further elucidation of their biologic effects, and how they may be controlled loom as the big problems of roentgenology at this time.

THOMAS A. GROOVER, M.D.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY *visiting New York City, are invited to make the office of* THE JOURNAL *(76 Fifth Avenue, New York) their headquarters. Mail, packages or bundles may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this column solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. Charles L. Martin, Dallas, Texas.
Twenty-eighth annual meeting, Montreal, Can., Sept. 20–23, 1927.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. Fred M. Hodges, 801 West Grace St., Richmond, Va.
Annual meeting, Washington, D. C., May 16–20, 1927.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. Robert J. May, St. Luke's Hospital, Cleveland, Ohio.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Sherwood Moore, St. Louis, Mo.
Annual meeting, Atlanta, Georgia, Nov. 15–18, 1926.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. R. A. Arens, Michael Reese Hospital
Meets monthly on second Friday from October to May (except during month of December) at Virginia Hotel. Dinner at 6 P.M., scientific session at 8 P.M.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. James H. West, 8314 Euclid Ave.
Meetings are held at 6 o'clock at the University Club, on the fourth Monday evening of each month from September to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. Henry L. Ulbrich, 1130 E. Grand Blvd.
Meets monthly on second Friday from October to May, at Wayne County Medical Society Building.

CENTRAL ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. H. C. Kariher, Decatur, Illinois.
Regular meetings held quarterly.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. M. C. Sosman, Peter Bent Brigham Hospital, Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. Eugene V. Powell, 217 East 42d St.
Meets monthly on second Monday, New York Academy of Medicine.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. D. S. Childs, 316 Gurney Bldg., Syracuse, N. Y. Three meetings a year—April, August and November.

PACIFIC COAST ROENTGEN RAY SOCIETY
Secretary, Dr. Harold B. Thompson, Seattle, Wash.
Two meetings a year.

ROENTGEN RAY SOCIETY OF CENTRAL PENNSYLVANIA
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Two meetings a year, April and October.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Eugene Pendergrass, University of Pennsylvania, Philadelphia.
Meets monthly on first Thursday evening, Pennsylvania Hospital.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. S. C. Davidson, Highland Hospital.
Meets monthly on the first Friday evening at 7.45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB
Secretary-Treasurer, Dr. L. R. Sante, Metropolitan Building.
Meets first week of each month. Time and place of meetings designated by president.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. Davis Spangler, Dallas, Texas.

BRITISH EMPIRE

BRITISH RÖNTGEN SOCIETY
Meets on the first Tuesday of each month from November to June inclusive, at 8.15 P.M., at the British Institute of Radiology, 32 Welbeck St., London; W. 1.

BRITISH INSTITUTE OF RADIOLOGY
Secretary, Dr. John Muir, 32 Welbeck St., London, W. 1.
Meets at 32 Welbeck St., but regular dates and times of meeting have not yet been arranged.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8.30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

RADIOLOGICAL SECTION, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. C. A. Anderson, The Hospital, Dunedin.
Meets at Dunedin, New Zealand, during February, 1927.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

CANADIAN RADIOLOGICAL SOCIETY
Secretary, Dr. E. C. Brooks, Montreal.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch.
Meets annually.

* Secretaries of societies not here listed are requested to send the necessary information to the editor.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHOSLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prag, 11/52.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Torino, Torino.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs S. A. Reinberg and S. G. Simonson.
Meets annually.
Fifth Annual Meeting in Kiev, Ukraine, May, 1927.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and S. A. Novotelnow.
Meets monthly on the first Monday at 8 o'clock in the State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies meets every second month except in the summertime:

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Meets in Copenhagen.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets on the first Tuesday of each month from October to July.

VIENNA LETTER, OCT. 5, 1926
FROM OUR SPECIAL CORRESPONDENT

A NEW ELECTROCARDIOGRAPHIC STATION IN VIENNA

The Sanatorium Loew, one of the oldest and leading private medical institutions in Vienna has been equipped with the most modern cardiograph, in connection with a new roentgen-ray installation, fitted up with a new modified orthodiagraph. The design of these apparatus was compiled by the most celebrated heart specialists, roentgen experts and physio-therapists of Austria, while the technical execution has been intrusted to the care of special electrotherapeutic engineers, who endeavored to create the most perfect apparatus imaginable at present. The orthodiagraph records the size and position of the heart and of the great vessels, while the electrocardiograph makes clear whether a certain heart affection is organic or functional. The extraordinarily precise apparatus, the electrocardiograph, whose inventor is Einthoven, the winner of the last medical Nobel prize, registers even such a minute current as that originating through the action of the heart muscles, drawing a curve of microscopic waves, with the aid of a special optical system, the curves being photographed on a film. The apparatus renders very valuable service in cases of arrhythmia, which though being unimportant in most cases, gives rise to very annoying sensations in the patient, and often leads to hypochondria. The electrocardiograph reveals exactly whether this manifestation is a passing symptom or a real disease. It is still more important in the control of the further course of the arrhythmia. Patients who fear the consequences of a narcosis upon the heart are examined with the orthodiagraph and cardiograph, and upon a favorable finding are assured that the heart will bear the results of anesthesia. The medical staff of the sanatorium will also carry on scientific experiments with the new apparatus.

IDIOCY AND MYXEDEMA TREATED WITH ROENTGEN RAYS

Dr. Wolfgang Wieser, a Vienna roentgenologist, made experiments on the irradiation of the thyroid and the remnant of the thymus, in cases of imbecility and myxedema. It was a long time before he could fix the adequate dose which is apt to stimulate and at the same time to inhibit certain secretory functions of these glands. He finally succeeded in arriving at what he believes to be the correct dose, the details of which are not yet published

because Dr. Wieser believes that the number of his cases is not yet sufficient to arrive at definite conclusions. During the last three years he has treated altogether 300 children, selected from 700 examined. The most notable effect was produced in the children in whom besides a mental debility there was also physical weakness. In these a change for the better was noticeable after treatments extending over three months. The idiotic children, who could not speak at all, started to utter syllables after three months' treatment and were able to talk sufficiently well after a year, so that they could attend school.

IRRADIATION OF THE SPLEEN IN CASES OF FUNCTIONAL UTERINE HEMORRHAGE

Dr. Imre Gábor, adjunct to the gynecological clinic of Professor Kenézi at the University of Debretzin gave an address on the above subject at the recent meeting of the Hungarian Gynecological Society. He said that the irradiation of the spleen in uterine bleedings, not caused by tumors, was first attempted by Stephan. Soon after him Nürnberger, Zwiefel, Scholten and others followed. Their results were varying. While Nürnberger and Scholten gave accounts of 70 per cent cures, Sippel saw no result at all. The explanation of this, according to Gábor, is that during this time they have done the irradiations indiscriminately. When this is the case, we have to regard not only the character of the bleeding but also the age of the patient, and the time of application. The effect of the irradiation is due to the destruction of very many leucocytes and lymphocytes, and the coagulative action of the ferment liberated from the decomposition of these cells. This process is called by Neuffer, thrombokinase. Encouraged by this coagulative action upon the blood, the method has also been tried in other diseases connected with copious bleedings: purpura hemophilia, gastric ulcer, etc. "Very exact researches have been made also in our clinic," Gábor continued, "as to the mode of action of the method, and we came to the conclusion that the efficaciousness of the method is not due to the thrombokinase, but it is much more probable that it is owing to a hormonic effect on the interrelation of the spleen and ovary. In our clinic the exposures are made in not quite a true lateral position of the patient, after determining the seat of the spleen on an area 13 × 18 cm., corresponding to the dullness. We apply 80 per cent of the erythema dose through 5 mm. aluminum, with a wave length of 0.016A. The exposures are always made at the time of menstruation and never in the intervals. Since 1922 we have applied this treatment in 51 cases; 40 had metrorrhagia and 11 menorrhagia. We regarded all patients as cured, who in three successive months menstruated at the regular time and for a regular period. Out of the 11 cases of menorrhagia, 5 were cured. Out of the 40 cases of metrorrhagia 14 were cured. The best results were achieved in young girls. Comparing our results with those of Nürnberger we have not reached the high percentage of cures which he reported. We failed to obtain any good results in cases of adnexal diseases, in contrast with Hornung and Radetzki, who report excellent results. We have had no untoward after effects, not even in a single case, though we followed up 36 of our cases. Being a safe and harmless method we advise its trial in every case of functional bleeding."

ELECTRICAL ACCIDENTS WITH ROENTGEN-RAY APPARATUS

Since within a relatively short time two fatal accidents occurred in Hungary in connection with roentgen machines, Dr. Béla Kelen, professor of roentgenology at the Budapest Royal University gave a lecture on the above subject. He stated that the progress of roentgenology necessitated the building of powerful machines, which of course increase the dangers to those handling them. The danger is still further exaggerated by the erroneous opinion held concerning the old inductor apparatus, namely, that they are entirely without danger and hence no special precaution is necessary in handling these roentgen apparatus. This is not the case. The inductor machines, though their output of energy was between very narrow limits, still could not be said to be fully harmless. As early as 1906 a child in Italy succumbed in consequence of touching the high tension

wires. The first accident with the transformer apparatus occurred in Paris with a Gaiffe machine; the details of the fatal accident are unknown. The second occurred in Helsingfors with a Siemens apparatus. In this case the roentgenologist and his nurse lost their lives because one pole of a tube under current was held by the doctor and the other by the nurse, their elbows touched and thus the circuit was closed. The third accident occurred in Pecs, Hungary, with a Koch and Sterzel "Diax" apparatus. The unfortunate doctor, only twenty-six years of age, was repairing the high tension wire and by chance touched the switch pedal with his foot, thereby setting the transformer in function, the high tension current causing the death of the operator.

As to what constitutes the great danger for the operator from roentgen machines, the investigations of Kelen and others, and especially that of Professor Jellinek in Vienna have revealed that the alternating current is very dangerous on account of the constant and regular fluctuation of the tension and intensity causing tetanus of the isolated striated muscles and fibrillary twitchings on the heart. Of the important organs, the most sensitive to alternating current is the heart. Sometimes a relatively weak sinusoidal current of an electric apparatus—Pantostat—is capable of killing an individual. It seems, however, that there is an idiosyncrasy against alternating current. Lewandovski describes a case in which a minimum intensity current caused the death of an electrician. In this case it is quite certain that an exaggerated sensitivity existed. Kelen drew a parallel between the alternating current and chloroform and stated that there is an analogy between them. Just as the inhalation of a minimal quantity of chloroform may cause death, in the same way quite weak, otherwise inefficacious currents may cause fatal issue through paralysis of the heart. Meinhold regards the status thymolymphaticus as a predisposing cause for the hypersensitivity. As to the intensity of the fatal current, the opinions are divergent. As the alternating current exerts its very dangerous action only upon the heart, the fatal intensity has been determined with experiments on animals. The committee which was sent out in France for the study of this question determined that in a dog of medium size 100 milliamperes in the direction of the axis of the heart may be fatal. The action of the alternating current is dependent also upon the number of alternations. According to Nernst there is a connection between the number of oscillations of the alternating current and the physiological action brought about by the current. According to this Nernst law the most dangerous is the 42–50 frequency, something less dangerous is 500 frequency, and the physiological action considerably diminishes at 1200 frequency. The touching of wires carrying alternating high tension currents is wholly analogous with a short circuit. In such instances currents are produced, the number of oscillations of which is the multiple of the number of frequency of the alternating current. Such high numbered oscillation currents can always be found with roentgen-ray transformers. The physiological action of these currents is not as yet clear. It is undeniable that every single roentgen apparatus yields such high tension current and that this may be fatal in certain circumstances: idiosyncrasy, heart failure, a blow on the heart or on the central nervous system. All safety appliances which are used now are of value only in case the roentgen operators take the utmost precautions. The dangers cannot be eliminated with safety devices; these can only diminish the danger. The only precautionary measure besides competency and expertness is increased attention. In industrial works high tension installations are handled with the greatest precaution. The localities in which the dangerous machines are placed are kept under seven locks and without the presence of the engineer no one is allowed to cross the threshold. In contrast to this the acquisition of a roentgen-ray apparatus is only a question of money, having nothing to do with any technical competency. The dangers awaiting the patient and doctors can be avoided only with the strict observation of the rules relating to the management of roentgen apparatus and by the control of the competency of all those

who deal with the apparatus, be he roentgenologist or technician.

THE RADIOLOGICAL REVIEW

Announcement is made that the *Radiological Review* which has been published bimonthly will become a monthly publication beginning with the January, 1927, issue. The journal is devoted to the progress in roentgenology and radium therapy from the standpoint of the general practitioner and the specialist in branches other than radiology. It is published by the Radiological Review Publishing Company of Quincy, Illinois.

CLEVELAND RADIOLOGICAL SOCIETY

At the recent meeting of the Cleveland Radiological Society Dr. E. P. McNamee was elected president and Dr. James H. West, 8314 Euclid Avenue, was elected secretary for the coming year. The meetings are held at 6:00 P.M. at the University Club on the fourth Monday evening of each month, September to April inclusive.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

GRUNDRISS DER GESAMTEN RÖNTGENDIAGNOSTIK INNERER KRANKHEITEN FÜR ÄRZTE UND STUDIERENDE. (Outline of General Roentgen Diagnosis of Internal Diseases for Physicians and Students.) By Dr. Fritz Munk, a. o. Professor für innere Medizin an der Universität Berlin. Third edition, revised. Paper. Pp. 316, with 297 illustrations. Leipzig: Georg Thieme, 1926.

Apart from the advantages of a review text on diagnosis for roentgenologists, there is a distinct need for this among students and the increasing number of physicians who, though not engaged in roentgenology, wish to know the possibilities of roentgen diagnosis and to become acquainted with this diagnostic method in the interests of their patients as well as themselves. Twelve years have passed since the appearance of the first edition of this work, and the author is convinced that it fills a real need despite the number of comprehensive texts on the same subject that have since become available. There are certain advantages in a briefly presented review text covering all fields of internal medicine as a guide to the student and for the orientation of the practitioner and clinician.

In accordance with this aim, the physical and technical aspects of roentgen diagnosis are treated only briefly in the introductory chapters. Then follow chapters on the heart, the other thoracic organs, the esophagus, the stomach, the intestines, the other intra-abdominal structures, the urinary apparatus and the extremities. The value of the text is greatly enhanced by numerous illustrative roentgenograms which are excellently reproduced and are very instructive. It is the author's feeling that although line diagrams have their value the actual roentgenogram is of greater instructional value because the disadvantages as well as the advantages in interpreting the film become evident to the student.

Of necessity, the treatment given to the various subdivisions is brief; but all the important aspects seem to be covered. There is one exception to this, however, in the final chapter on the roentgen examination of pathological processes in the extremities. Professor Munk has had a special interest in this field, and presents numerous original roentgenograms describing a number of unpublished findings regarding arthritic processes, including the roentgenologic symptomatology. This section gives an exposition of the roentgenological aspects that permit a classification of joint diseases. There is appended a rather brief and somewhat unsatisfactory bibliography relating to roentgen diagnosis. Although many of the references are those of the more recent contributions, we find very few titles of contributions by Americans. This may of course be due to the difficulty in obtaining American publications during post-war difficulties. Nevertheless the modern developments in diagnosis seem to be included in this work. There is mention of cholecystography by the Graham method and of the various forms of pneumography.

B. Cohen.

INTERNATIONALE RADIOTHERAPIE. BESPRECHUNGSWERK AUF DEM GEBIETE DER RÖNTGEN-, CURIE-, LICHT- UND ELEKTROTHERAPIE. (International Radiotherapy. Reviews in the Field of Roentgen-, Curie-, Light-, and Electrotherapy.) Volume 1, 1925–1926. Organized and edited by J. Wetterer, M.D. Cloth. Price, 64 Reichsmark. Pp. 1061. Darmstadt: L. C. Wittich, 1926.

A natural development of progress in the various fields of science is the growing multiplicity of contributions from all directions and from all manner of intellects. The beginnings of any particular branch of science are ushered in by some modest contributions from the few pioneers exploring the new domain. Once the way has been shown and the roads laid out, we find adventurous settlers and exploiters trooping in; and the result is a veritable avalanche of observations expecially in those fields where popular interest or the "call of humanity" furnishes the appeal. Roentgenology offers a typical, though no unique example of the situation.

The question arises in the mind of the thoughtful student, "What is to be done with the ever increasing mass of material presented?" One may take a gloomy attitude which assumed a sadly grotesque turn in the case of a gifted scientist who committed suicide because he could no longer keep abreast with modern developments in his own field. We recall, on the other hand, our own rather vandal joy when as a schoolboy we first heard about the famous library at Alexandria that was burnt

down by the Arabs with the complete loss of papyrus manuscripts containing the accumulated knowledge of bygone civilizations.

The situation, however, must be faced positively and constructively and the solution as we see it lies in some form of systematic indexing and abstracting. This, however, represents merely the bookkeeping side and is naturally not the whole solution. In order that consistent progress shall be made along any front, it is necessary that the accumulated knowledge be not only suitably arranged but also intelligently digested. This means the production of monographs by specialists who are able to crystallize the usually amorphous and occasionally divergent facts and pseudofacts into a consistent and balanced perspective. Thus, in order to have intelligent progress there is equal need for the researcher, the indexer (bibliographer), and the type of specialist we have described.

Dr. Wetterer, in the work under review, seeks to furnish not only the "bookkeeping" of radiotherapy but also a series of brief monographs covering special fields. Under radiotherapy the author includes roentgen-, curie-, light-, and electrotherapy.

This volume contains references to over three thousand of the most important international contributions in the above fields. A large number of them are given in abstract form and the remainder are mentioned in the monographic reviews. The abstracts are given under the following headings: physical and technical; radiation therapy and related subjects; biological effects of radiations of various kinds; diseases of the skin and its adnexa; gynecological diseases; malignant tumors; tuberculosis; internal medicine; urology, venereal diseases; stomatology, oto-rhino-laryngology; eye diseases. These abstracts cover about four-fifths of the volume.

Obviously the value of this laboriously collected material is dependent upon its indexing. This seems too self-evident even to be mentioned. Yet in this very respect, we believe that the present work is sadly lacking. An author index is available and is no doubt complete. The subject index is merely a table of contents three pages long. There seems to be no attempt at subject indexing such as one would expect if he sought this volume for information. It is to be hoped that this vital deficiency will be corrected in subsequent volumes.

One can hardly do more than mention the review articles contained in the remaining 250 pages of this volume. They are as follows:

1. The development of the technique of roentgen therapy in Germany during recent years. By Robert Jäger.

2. The importance of the roentgen dose unit, R, for therapy. By Robert Jäger.

3. The problem of dosage in international roentgen-radium therapy from 1924 to the middle of 1926. By M. Jona.

4. New methods for measuring quantity and quality of roentgen rays. By Iser Solomon.

5. Radium mining in Australia (1923–1925). By H. Flecker.

6. Gamma-ray therapy. By F. Sluys and E. Kessler.

7. The development of radiation therapy during the years 1924–1926 in the field of gynecology in Germany and other countries. By Wilhelm Lahm.

8. The treatment of skin carcinoma. By C. B. Hörnicke.

9. The development of roentgen therapy in France in 1924–1926. By Robert Coliez.

10. The present status of radium therapy in America. By Dr. Schmidt.

11. Radiotherapy in Turkey (1924–1926). By J. Wetterer.

12. Heliotherapy of surgical tuberculosis. By Dr. Rollier.

13. Recent results of the radiotherapy of Basedow's disease and of hyperthyroidism. By R. Fritz Weiss.

14. The effect of radiation upon the eye. By Wolfgang Hoffmann.

15. Roentgen therapy in dermatology. By J. Wetterer.

Anyone aware of the situation can have nothing but admiration and respect for the task undertaken in this monumental effort. That the absence of an adequate subject index constitutes a serious defect in the present volume so far as the abstracts are concerned need not detract from the significance of the work, although it limits its utility. The effort to present a series of monographic reviews deserves only the highest praise.

The time is approaching, if it is not already upon us, when competent abstracting and indexing of radiological literature will have to be done and promptly if we are to be saved useless effort, inundation and despair. We have not been backward in this matter in America. In addition to the occasional abstracts that appear in a number of general medical journals and in various special journals, the American Journal of Roentgenology and Radium Therapy has during the past few years published increasing numbers of abstracts of the world's radiological literature with the ultimate aim of completely covering all that is published on this subject. During the past year probably one thousand

such abstracts have been printed and properly indexed. It is clear, therefore, that the readers of this Journal have presented to them a current account of the developments in this and closely related fields, a compilation which is of undoubted immediate benefit and which will prove invaluable as the years roll by as a reference source on the development of radiology.

Barnett Cohen.

BOOKS RECEIVED

Ergebnisse der medizinischen Strahlenforschung (Röntgendiagnostik, Röntgen-, Radium- und Lichttherapie). Volume II. By H. Holfelder, Frankfurt a.M., H. Holthusen, Hamburg, O. Jüngling, Tübingen, and H. Martius, Bonn a Rh. Paper. Price, 52.50 Marks; Bound. Price, 57 Marks. Pp. 594, with 520 illustrations and 3 photographic plates. Leipzig: Georg Thieme, 1926.

Grundriss der gesamten Röntgendiagnostik innerer Krankheiten für Ärzte und Studierende. By Fritz Munk M. D., a.o. Professor für innere Medizin an der Universität Berlin. Third edition, revised. Paper. Pp. 316, with 297 illustrations. Leipzig: Georg Thieme, 1926.

Internationale Radiotherapie. Besprechungswerk auf dem Gebiete der Röntgen-, Curie-, Licht- und Elektrotherapie. Volume I, 1925–1926. Organized and edited by J. Wetterer, M. D. Cloth. Price, 64 Reichsmark. Pp. 1061. Darmstadt: L. C. Wittich, 1926.

Die Harnorgane im Röntgenbild. (Archiv und Atlas der normalen und pathologischen Anatomie in typischen Röntgenbildern. Supplement No. 37 to Fortschr. a. d. Geb. d. Röntgenstrahlen.) By Eugen Joseph, M. D., Berlin. Paper. Price, 31.50 Marks. Bound. Price, 36 Marks. Pp. 58, with 23 text figures and 153 illustrations on 38 plates. Leipzig: Georg Thieme, 1926.

INTERNATIONAL ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

PEIPER, HERBERT, and KLOSE, HEINRICH. The fundamentals of myelography. *Arch. f. klin. Chir.*, 1925, CXXXIV, 303–387.

Myelography is an exceedingly fruitful method of great promise to the surgeon and neurologist in the diagnosis and planning of operation for compressions of the spinal cord. It gives information regarding the level, the extent, and in some cases, the nature of the stenosing process. It makes use of the visualization of small portions of the subarachnoid space by a specific, relatively heavy oil. Usually about 2 c.c. of a 20 to 40 per cent solution of iodipin Merck is employed. The injection is made preferably by puncture of the cerebellomedullary cisterna, with the patient in a sitting position. An injection below the level of the tumor is unsatisfactory. For interpretation of the pictures obtained, control roentgenograms are necessary. Lateral views frequently give important information.

The indications for myelography are all suspected cases of compression processes of the spinal cord, such as tumors, tuberculous spondylitis (sequestra, abscesses), chronic adhesive meningitis, meningitis cystica circumscripta, and many spinal fractures.

The arrest of iodipin may be an early sign of tumor, which may be positive sooner than the neurologic symptoms, and certainly indicates the existence of an obstructive process. In general, however, the occurrence of the symptoms in relation to the appearance of the obstruction has not yet been fully worked out. Nevertheless, it is the most striking and convincing sign of an obstructive process, provided the technique of injection and the subsequent roentgenography are carried out correctly. The continued presence of portions of iodipin at the suspected level indicates a tumor, because iodipin will remain adherent to the sides of a tumor where the channel is otherwise open. Where the passage of iodipin was entirely free, a stenosing process was never found by the authors in any of their cases. In deep-lying tumors of the cauda the shadow of the lower level of the iodipin is of importance.

Irritative disturbances in the form of headaches and sensory root irritation symptoms are often present, but they never become alarming and are easily controlled with drugs. As a rule, they did not last longer than five days at the most. Permanent injuries, up to two years, have never been observed in the large number of patients thus far examined. Recently made, special iodipin preparations have caused few or no irritative symptoms. A slight rise in temperature is probably caused by stimulation of the thermogenic center.

A large number of animal experiments were made to determine whether any histological injuries to the spinal cord could be demonstrated. Doses of 0.1 to 0.05 c.c. iodipin in rabbits showed no demonstrable histological changes in the spinal cord, although this quantity is by no means small for the animal. This dose corresponds to more than 2 c.c. for a human being. In the case of the rabbit, ten times the quantity is tolerated although with pronounced irritative symptoms. For human beings it appears generally to be of no use to exceed the dose of 2 c.c. This might be necessary where it is desired to delimit spinal cord tumors from above and below.

The clinical portion of this paper is based upon observations in 12 cases of diseases of the spinal cord involving obstruction of the channel. These cases are cited and, in addition, an extensive series of animal experiments is reported. In the animal experiments a study was made of the effects of iodipin upon the tissues with which it came in contact. It is emphasized that myelography is a harmless diagnostic procedure, but its performance is justified only when undertaken by absolutely reliable and competent workers. It belongs in the large hospitals, and under no circumstances outside of them. This is the primary and cardinal requirement.

PIERSON, J. W. The localisation of brain tumours by ventriculography. *Brit. J. Radiol.* 1925, XXX, 384–387.

The early diagnosis and localization of brain tumors will enhance in two ways the patient's chances of complete recovery: (1) it will avoid the use of palliative methods of treatment, and (2) it will avoid the necessity for exploratory operations. Some tumors are so situated in the brain that they automatically localize themselves by their neurological manifestations. The use of roentgen rays is not indicated in dealing with such tumors except for corroborative evidence.

Ventriculography, as devised by Dandy, has

made possible the demonstration of other anatomical changes in the brain which cannot be detected by the routine roentgen examination. The silent areas of the brain harbor at least 35 per cent of all the brain tumors. There is no way to localize them except by means of ventriculography. Not all brain tumors affect the ventricles, but any tumor which is of sufficient size to cause pressure symptoms will cause one or more changes in the ventricles, and these changes can be revealed by the roentgenogram. It is possible to exclude the presence of suspected tumors in 15 per cent of the cases on the basis of negative findings following a complete ventriculographic examination. This examination consists in the removal of cerebrospinal fluid from the ventricles and substituting air. The air which has been introduced will naturally seek the highest point of the ventricular system. Each lateral view is examined and the head is then carefully turned with the occiput down. This position will give the size, shape and position of the anterior horns of both lateral ventricles and will show a cross sectional view of the third ventricle. This anteroposterior view is extremely important in the determination of lateral dislocations of the ventricles. Finally a posteroanterior examination is made, which gives the desired information regarding the body and the posterior and descending horns of the lateral ventricles.

The changes produced by the tumors are manifold, therefore the interpretation of the roentgen-ray findings is difficult and requires a large experience. However, increasing practice brings more assurance and makes the localization more certain. The procedure is dangerous and complicated but in competent hands it should not be nearly so dangerous as an exploratory craniotomy, and it frequently yields more information than the latter operation. It will incur a heavy mortality unless used only by one thoroughly skilled in intracranial surgery.

PILZ, W. Roentgen examination of habitual dislocation of the shoulder. *Arch. f. klin. Chir.*, 1925, CXXXV, 1–22.

It is found that certain bone changes are practically always present in cases of habitual shoulder luxations; and roentgenography may be depended upon to reveal an adequate idea as to the condition of the osseous portions of the joint. It is essential, however, to perform a systematic examination and interpret the findings critically.

The author makes the examination as follows: A ventrodorsal roentgenogram of the shoulder is taken first with the patient either sitting or standing, and precautions are taken that any free bodies possibly present are not manipulated upward into the joint. There next follows a roentgenoscopy of the shoulder with special attention to the head of the humerus, and if necessary, a dorsoventral roentgenogram is taken of any typical defect observed in the humerus. The final examination is made on a craniocaudal roentgenogram of the shoulder blade. Comparison roentgenograms taken of the healthy side are of advantage and frequently are absolutely necessary. A ventrodorsal roentgenogram of the luxated upper arm is frequently desirable. This plan of examination takes a good deal of time and is much more expensive than the customary procedure; but it is justified since habitual shoulder dislocations do not occur with very great frequency. The examinations suggested are not diagnostic novelties but absolute essentials. The great advantage of the accurate roentgenological diagnosis of the condition within the shoulder joint is the guidance given to the surgeon in the matter of treatment.

These conclusions are based on an experience since 1913 with 18 cases of habitual dislocation of the shoulder, three of the cases being bilateral. Changes in the bone were found to be more frequent than is customarily assumed. The typical roentgenological defects are found in the head of the humerus in the socket and joint bodies. The head of the humerus observed ventrodorsally shows an indistinct contour and a narrow wedge-shaped shadow extending from the head toward the interior. This shadow represents the mesial boundary of the defect. The size of the defect is usually considerable, in one case being practically one-third of the contour of the head of the humerus. A striking, washed-out appearance of the structural markings associated with a greater or less disappearance of the shadow of the head, corresponding to the position of the typical defect, permits diagnosis at the first inspection. There are, however, a number of cases in which the roentgen diagnosis of the defect is not so easily made. A closer examination of the details is necessary.

In the shoulder blade itself, it is impossible to detect roentgenologically the usual presence of tear of the glenoidal margin from the anterior edge of the socket. This injury corresponds to a parallel mechanical osseous injury to the anterior arm of the socket because of the dense and resistant structure of the margin. It is only when there is in addition a loosening of the adherent periosteum on the frontal surface of the scapula, with a new development of bone out of this periosteum, that positive evidence is registered on the roentgenogram. Such changes were observed roentgenographically only three

times in a total of 17 cases. On the other hand, such changes were observed very frequently in the bony portion of the edge of the socket at operation. The joint bodies may be either free or attached, and are not a rarity. Such bodies may be overlooked at operation unless previously located in the roentgenogram. These bodies, however, are very easily screened by the darker shadows of the humerus and shoulder blade and must be sought with especial care. They are best disclosed in the ventrodorsal roentgenogram when they lie in the open angle between humerus and shoulder blade.

PINCHERLE, PINO. Paralytic dilatation of the esophagus and secondary carcinoma. *Radiol. med.*, March, 1926, xiii, 170–176.

A woman aged fifty-one had had difficulty in swallowing since she was ten years of age. She had learned to use a sound and wash out the stomach to relieve the condition and had continued for forty years. Within the last two years swallowing had become increasingly difficult, until she could take only liquid food; she had lost weight and was in poor general condition. Roentgen examination showed an enormous dilatation of the esophagus, which filled three-quarters of the right half of the thorax. There was a carcinoma of the lower third of the esophagus. When the contrast liquid was swallowed it stopped for some time at the upper level of the carcinomatous infiltration and then suddenly, as if a spasm had yielded, descended through the open cardia into the stomach. After six hours almost all the barium still remained in the stomach. The patient's condition grew rapidly worse and a Witzel's fistula was established. Eighteen days later she had a sudden hemoptysis and died. The carcinoma had penetrated the right lung and eroded a vessel. Autopsy showed nothing abnormal in the stomach or pylorus, and the retention of food was therefore evidently due to spasm of the pylorus caused by the distant affection of the esophagus.

Not long afterward the author had occasion to observe a similar case with Lenk. The patient was a woman of forty-five who for three years had had difficulty in swallowing food, and sometimes even water. For the past few weeks she had grown rapidly worse and in two months had lost 2 kilograms in weight. Roentgen examination showed cardiospasm of an extreme degree with dilatation and elongation of the esophagus and a neoplasm of the lower third of the esophagus. The esophagus seemed to be divided into two parts, an enlarged tube which passed down to about three finger breadths above the diaphragm and a sac the size of an apple below the diaphragm. The two parts were connected by a short, irregular rigid canal. The course of the disease was similar to that in the first case. There were two zones of spasm, one above the tumor and the other at the cardia, which made it possible to observe the ectasia of the last tract of the esophagus below the tumor. It is hard to say whether the double spasm observed in both cases was due to the carcinoma or to the dilatation, as both are accompanied by spasm. In the first case it is probable that the esophageal spasm was due to the dilatation and the pyloric spasm to the carcinoma, while in the second it is probable that the spasm of the cardia was related to the ectasia of the esophagus and that of the esophagus was dependent on the tumor.

In view of the long duration of the disease, particularly in the first case, it is probable that it was a paralytic dilatation of the esophagus and that the carcinoma developed secondarily and independent of the dilatation. It is possible that the prolonged mechanical irritation of the frequent sounding and chemical irritation due to fermentation of stagnated food were factors in the development of the carcinoma.

REIMER, H. Fracture of the fabella. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 568–570.

The fabella may be regarded as belonging to the periarticular sesamoid bones. It may be distinguished from them by the fact that they are usually bounded by a free cartilaginous surface in the direction of the joint, while the fabella usually possesses only a serous surface which is distinguished in the roentgenogram as an elliptical section with double parallel contours.

A case of tear fracture of this sesamoid bone was observed in a man with bilateral knee distortions. The patient, age fifty-two, had been hit by an automobile in such a manner as to cause a sudden over-stretching of both knees. The roentgenogram disclosed an interesting picture. Lateral view of the right and left knees showed at the level of the ligamentous insertion of the head of the gastrocnemius a sesamoid bone the size of a small bean and with sharp contours. The right sesamoid was fractured horizontally into a larger upper fragment and a smaller lower one, the two fragments being considerably dislocated. Nothing pathological was observed in the contours of the knee joints. More exact measurements for purposes of localization confirmed the assumption that the fractured sesamoid bone belonged to the lateral gastrocnemius head. The patient recovered after rest; and eleven weeks after the

accident a roentgenogram showed the upper fragment clearly visible while the lower one was considerably resorbed.

RAND, CARL W., and NIELSEN, JOHANNES M. Fracture of the skull: Analysis of one hundred and seventy-one proved cases. *Arch. Surg.*, September, 1925, xi, 434–458.

An analysis is given of 171 cases admitted to the neurosurgical service of the Los Angeles General Hospital, of proved fracture of the skull, with a mortality of 25.7 per cent. An operative mortality of 47.7 per cent was obtained in 38 patients who were operated upon. Linear fractures occurred 145 times, 93 being on the right and 52 on the left. The most common site of linear fracture was from the posterior parietal region coursing downward and forward through the temporal bone to the neighborhood of the external auditory meatus. Depressed fractures occurred 26 times, about equally divided between right and left. The most common location was the frontal region, the parietal region being next in frequency.

Sixty-eight per cent of the deaths occurred within forty-eight hours after injury. All the deaths after the fifth day were due to complications, viz., septicemia, brain abscess or meningitis, with exceptionally a subdural hemorrhage of many months' standing.

RÖSLER, HUGO; and WEISS, KONRAD. Change in the course of the esophagus by dilated left auricle. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 717–722.

A recent paper by Gäbert gives the impression that a dilated left auricle can cause only a right sided deviation of the esophagus. Observations by the authors show that, although this is probably the usual effect, a deviation of the esophagus to the left can also take place. Seven cases are briefly described and sketched. These show that among cases of purely mitral disease there is a small proportion of cases in which the esophagus assumes the left-handed lengthening as a result of the dilated left auricle. This finding also occurs in combined valvular conditions, although there is no strict proportionality between the degree of auricular dilatation and the degree of deviation of the esophagus. The degree of esophageal deviation is determined, amongst other things, by the spatial conditions in the thorax. In general, the esophagus in a longer thorax will be forced to deviate less sharply between the left auricle and the spinal column than it will in a shallower thorax. In one case there was evidence that the position of the hiatus esophageus may have an effect upon the course followed by the esophagus.

SANTE, L. R., and LEHMAN, E. P. Localization of lung abscess by the roentgen ray, with special reference to the use of the Hirtz compass. *Arch. Surg.*, September, 1925, xi, 394–407.

The large lung abscess rarely offers difficulty as regards localization and selection of the point for insertion of the exploring needle. The small abscess, with or without subsidiary abscesses, often requires repeated insertion of the needles in many directions if the surgeon is guided only by physical signs and by the findings obtained in the ordinary roentgenographic examination. By the use of the Hirtz compass the authors have been enabled to enter the cavity with assurance on the first introduction. A preliminary report is given of 3 cases of lung abscess in which the Hirtz compass was used with success. One of the cases offered a severe test of the accuracy of the method. The abscess in this case was presumably the result of rupture into the lung of a post-appendicitis, subphrenic abscess. In the lateral view it was seen that the infection traversed practically the entire lower lobe. This cavity was entered from the lateral direction although the skin markers of the Hirtz compass were placed entirely on the anterior surface of the chest.

The Hirtz compass was devised especially for the localization of foreign bodies. It is constructed of metal and consists of three movable horizontal arms which revolve in a horizontal plane about a fixed point. Each arm carries a vertical adjustable leg; adjustable both as to position along the extent of the horizontal arms, and as to height. The purpose of these horizontal arms and vertical legs is to form a framework for the support of a pivoted curved arm which describes a meridian arc of a sphere; this is pivoted at the center or common attachment of the vertical arms and is movable about its pivot throughout the entire upper portion of the sphere. An adjustable slide carrying an indicator rod held in the exact direct direction of the radius of the sphere is movable along the meridian arc. Zero marks are established on the vertical legs and on the indicator rod, measuring a distance equal to the radius on the sphere. For lung abscess localization, the indicator rod is replaced by a hollow needle.

Opaque, triangular markers are laid upon the chest and the distance that their images move with respect to the abscess cavity on the roentgen film, when the roentgen-ray tube is moved over a known distance, determines by

simple triangulation the distance of the cavity from the target and from the screen.

Any indistinctness of the image of the abscess renders the examination useless. In multiple, small abscesses without definitely discernible outline, and in gangrenous conditions of the lung where no well-defined wall can be seen the method cannot be used. A number of attempts are often necessary in the favorable case before an exmination suitable for localization is obtained.

Sante, L. R., and McCutchen, Lex G. Compression fractures of the spine. *Radiology* December, 1925, v, 490–494.

Compression of the body of a vertebra is a relatively common injury. This type of injury comprised 40 per cent of the 400 spinal injuries treated during the past five years at the City Hospital, and St. Mary's Hospital and Infirmary, St. Louis. The injury is the result of forced flexion of the spine. Eighty per cent of all compression fractures of the spine occur in the lower dorsal and upper lumbar region (between the tenth dorsal and third lumbar). While the lumbar vertebrae are the largest and strongest, injuries to their bodies are to be expected more frequently since they are the most cancellous in character and bear greater weight than do the dorsal or cervical.

Roentgenographically this injury is characterized by compression of the vertebral body either at the anterior or lateral margin. The cancellous portion of the bone is compressed, since the interarticular cartilaginous disc is elastic and incompressible; and because of this, the deformity resulting from an injury is readily detected. Where the compression of the body is at all pronounced the smooth curve of the spine is lost and definite angulation is produced even to the extent of a kyphosis or scoliosis. Both anteroposterior and lateral views of the spine are necessary for a diagnosis. In the anterior view the body of the compressed vertebra is narrowed, and may or may not be perceptibly broadened. If the width of the bodies is compared by drawing horizontal lines through the articular margins of the vertebrae, a definite disproportion is usually found. Normally from above downward the bodies of the vertebrae become successively larger, but this variation in width is uniform and in the same direction, and any disturbance of this normal relationship by the interposition of a narrowed body should be easily detected. The deformity is most frequently seen in the lateral view, the compressed anterior margin of the injured body producing a deformity suggesting "a cut of pie" in shape, which results in an angulation of the spine and kyphosis. Both anteroposterior and lateral views are essential, since conditions may arise in which the roentgenogram will not show the deformity in one of the views. For instance, if only one side of the vertebral margin is compressed the lateral view may appear normal. Likewise if there is compression of the anterior margin along with downward rotation, the anterior view may not show the lesion. Compression fractures of the spine must be differentiated from the following conditions: tuberculous spondylitis, hypertrophic spondylitis, pyogenic infections of the spine, Charcot's spine, malignant involvement, and pressure destruction of the vertebrae.

Schulze, Fritz. The diagnosis of benign solitary gastric papilloma. *Arch. f. klin. Chir., Berl.*, 1926, cxxxix, 198–203.

A description is given of a case occurring in a woman aged forty-six. The roentgenogram showed the stomach of the usual position and shape, with the lowest point about four fingers' width below the umbilicus. About one hand's breadth below the cardia there appeared a constant sharply circumscribed rarefaction around the edge of which the contrast material ran in a thin channel more slowly above than below. There was good peristalsis and pyloric function. The stomach was emptied in about four hours. The roentgenogram together with the clinical symptoms led to a diagnosis of carcinoma of the stomach.

A median laparotomy was performed, the stomach was opened and a tumor was found with a broad base on the posterior wall of the stomach and extending from the larger to the smaller curvatures. The tumor was removed and the wound sewed up. The patient has been complaining for the past year and a half of stomach trouble, and a recent reexamination indicates that the present difficulty is merely one due to adhesions. There is no sign of recurrence.

The histological examination of the tumor showed a thickened submucosa with papillary mucosal villi containing glands, the latter appearing to be very active in the central portion but more quiescent peripherally. There was no invasion into the deeper tissues.

It is clear that the clinical signs are not adequate to distinguish a benign, solitary papilloma. The roentgen procedure puts us in a position for judging such a tumor as an intraventricular benign tumor when a thorough critical interpretation is made of the results of the roentgenoscopy and the roentgenogram. The normal shape and position of the stomach with this form of tumor may be regarded as an

important diagnostic sign. It is emphasized that the roentgenogram alone ought not to be taken as a definitive diagnostic criterion.

SAUPE, ERICH. Dysphagia lusoria. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 740–743.

This disease is characterized clinically by the symptom of dysphagia and is caused by a congenital vascular anomaly. In typical cases the right subclavian artery springs forth either as the last branch of the aortic arch or as a branch of the left subclavian artery, then running toward the right either between the esophagus and trachea or between the esophagus and spinal column. The dystopic artery, by exerting pressure upon the esophagus, is capable of calling forth difficulty in swallowing, which symptom is very difficult to explain in the living patient. Cases are known in which this anomaly never produced any symptoms.

A description is given of 2 cases in which the anomaly was produced not by the right subclavian artery but by an unusual course taken by the aorta itself. The first case occurred in a man. There was a constriction of the esophagus caused by the aorta running behind the esophagus instead of in front. The roentgenogical findings were confirmed at autopsy.

In the second case which occurred in a woman, the finding was made incidental to a gastric examination. The roentgenogram showed a scoliosis of the thoracic spine which caused a slight shift of the heart toward the left. The esophagus in the sagittal plane showed nothing striking, but in the first and second oblique diameters the esophagus was displaced forward at the level of the aortic arch and showed some narrowing and indentation. The contours of the esophagus were smooth. The aorta was definitely recognized running behind the esophagus. This patient, however, had no acute symptoms except an indefinite sensation of pressure back of the sternum.

SCHWAB, ERNST. A case of malignant myoma metastases in the lung. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 733–734.

The woman had undergone a supravaginal amputation of the uterus for the removal of a very large myoma. Microscopic examination of the tissue showed it to be a malignant (sarcomatous) myoma. She appeared several months later with symptoms of acute respiratory distress, coughing and palpitation of the heart. The roentgenogram showed the thorax well expanded, the left diaphragm hardly recognizable, the left pulmonary field compactly shadowed in its lower half, with the upper limit of the shadow rising arch-like above. The rest of the left lung field showed flaky shadows. The right field showed no lung marking at all. There were curtain-like shadows running from the sternum downward to the middle of the field. There was a round shadow the size of a plum on the right at the level of the middle of the shoulder blade. The heart and mediastinum lay far toward the left, and there was an extraordinarily narrow trachea.

The whole roentgen picture indicated a fairly extensive right-sided pneumothorax and the structures observed in the left side could be interpreted in the sense of nodular processes such as are seen, for instance, in actinomycosis.

The patient died shortly and the autopsy revealed extensive and large nodular tumor metastases in both lungs. The right pneumothorax was caused by the breakdown of a softened tumor nodule. The right lung was atelectatic. Metastases were also found in the bronchial lymph glands. Microscopic examination of tumor nodules showed a fibrous structure with layers of cells. The cells were highly atypical, and there were many giant cell structures. There seems no doubt that in this case there was a metastatic process from the primary tumor in the uterus.

The cloudy curtain-like shadows seen in the roentgenogram corresponded to the outlines of the myoma nodules. The form and outline of the collapsed lung was rather unusual as compared with ordinary pneumothorax. It should be mentioned that the suggestion of actinomycosis was not supported by any clinical evidence and was therefore dropped.

In the present case metastases were found only in the lungs, all other structures appearing to be uninvaded.

SCHWARZ, G. The problem of gastric ulcer carcinoma from the roentgenological aspect. *Wien. klin. Wchnschr.*, Apr. 30, 1925, xviii, 478–481.

Exulcerated carcinomas of the small curvature may produce a niche in the roentgenogram which is very difficult to distinguish from that produced by simple gastric ulcer. As a rule, such a carcinoma niche is associated with an extensive stiffness of the small curvature, and in addition such niches may be recognized by their irregularity and size. A niche of conical shape should suggest carcinoma. The roentgenologist should consider the possibility of carcinomatous growth in cases not suspected clinically or roentgenologically when long periods of treatment do not cure, and when the niches are located in the pre-pyloric region or on the greater curvature. Should a case show regional spasm of the antrum it is wise to repeat

the roentgenological examination at intervals of three or four weeks. Should this antrospasm persist in the absence of other causative factors (such as nicotine uremia, pernicious anemia, etc.) suspicion should be directed to carcinomatous development even if the clinical picture is still that of gastric ulcer. The duodenum is very rarely the site of a carcinoma, hence such fears need not be entertained in the case of duodenal ulcer.

Since it is often difficult for the surgeon and even the pathologist, after examination of the tissue, to decide whether it is a calloused ulcer or a carcinomatous one, it is of course unreasonable to expect the roentgenologist to make a decision from his observation of mere shadows. There are numerous cases in which both the internist and roentgenologist agree that the case is one of simple ulcer only to find on operation that carcinoma is present. Three such examples are cited and sketched.

The fact that most of the cases reported have been found to occur in men is probably no mere accident. This is in some way related to the prevalence of gastric ulcer carcinoma in the pyloric region.

SESSA, PIERO. A case of anomaly of the bones of the feet. *Radiol. med.*, April, 1926, xiii, 249–252.

A child three years of age had pain and swelling of the lateral internal region of the middle tarsus. Roentgen examination did not show any inflammation of the bones but in the right foot there was a bipartite first cuneiform bone and a tripartite scaphoid, while in the left foot there was a trace of bipartition of the first cuneiform, shown by an irregularity of the anterior border of the bone in lateral projection; there was a spur which ran upward and forward more than normal, and there was a slight notch of the posterior border about the middle of the bone. According to Volkow the plantar segment of a bipartite first cuneiform is a homologue of the small accessory bone which is found in some animals on the plantar surface at the cuneometatarsal articulation, and is to be regarded simply as a sesamoid bone.

SILBERSTERN, E., and SINGER, S. The tumor-like appearance of tuberculosis in the roentgenogram. *Wien. med. Wchnschr.*, 1925, lxxv, 1910–1913; 2283–2288.

Askanazy has described a peculiar form of tuberculosis, which is tumor-like in appearance, and which although microscopically distinct from tuberculosis, shows macroscopically only slight tendency to necrose. The result is an abnormal size of the foci, with dense consistency because of the tendency to fibrous metamorphosis, a picture very much resembling tumor. The unusual development takes place not only in hilus gland tuberculosis but elsewhere in the lungs, and renders difficult the differentiation of pulmonary tuberculosis from primary or metastatic lung tumors.

A number of such cases were observed in the University Medical Clinic of Vienna, and 6 of these are cited as illustrations. In all of them the clinical picture was distinctly that of tuberculosis, but the roentgenograms showed the typical homogeneous, sharply outlined areas suggesting primary or metastatic lung tumors. In the particular group of cases discussed by the authors there has as yet been no opportunity to confirm any of the findings by autopsy examination. Nevertheless, the clinical evidence is particularly convincing. It may be that a systematic study of these peculiar tumor-like forms of pulmonary tuberculosis will disclose some characteristics that will permit a definite differentiation from real tumors.

SMITH-PETERSEN, M. N., and ROGERS, WILLIAM A. End-result study of arthrodesis of the sacro-iliac joint for arthritis—traumatic and non-traumatic. *J. Bone & Joint Surg.*, January, 1926, viii, 118–136.

Although many orthopedic surgeons hold the view that there is no such condition as traumatic sacroiliac arthritis, evidence is offered by the authors justifying the existence of this clinical picture. The diagnosis depends on a careful history and examination, and roentgenograms furnish corroborative evidence. The points to be looked for under roentgenographic interpretation are: (1) increased density along the margins of the joints; (2) irregularity of the joint line; (3) proliferative changes at the inferior margin of the joint; and (4) disalignment of the pubes. Only four out of 26 cases had negative roentgenographic findings.

The improved operative technique of the authors is given. This consists of an incision along the posterior two-thirds of the iliac crest, curving around the posterior superior spine, and then running parallel with the fibers of the gluteus maximus for a distance of 2 to 3 inches. The flap is reflected subperiosteally, exposing the lateral surface of the ilium. If the sacroiliac joint is projected on the lateral surface of the ilium, it will be found that the inferior border corresponds to the sacro-sciatic notch, and the anterior border to the median gluteal line. A window is removed from the ilium with a motor driven saw, this window extending posteriorly into the inferior sacroiliac ligament. The sacral joint surface is removed exposing cancellous bone and the joint cartilage is curetted with angulated curettes. After

denuding the bone block of cartilage, this same block is replaced and counter-sunk, so that its cancellous surface comes in contact with the cancellous bone of the sacrum, and the edges of the window are osteotomized.

An important procedure is the cytological examination of the cartilage and bone. The chief characteristics are erosion of the joint cartilage; replacement fibrosis, seen chiefly at the juntion of the cartilage with the underlying bone but also in the medullary spaces; in some cases replacement fibrosis is so extensive that no cartilage is found, the joint surfaces consisting entirely of fibrous scar tissue; in some cases localized areas of hemorrhage with blood pigment were seen within the areas of fibrosis.

The end results have shown complete recovery in 22 out of 26 cases, partial recovery in 2 and failure in two. The high percentage of successful recovery is justification for the correctness of the diagnosis and the treatment, and should be accepted as proof of the reality of the condition.

Sosman, Merrill C. A consideration of aneurisms of the internal carotid artery and tumours at the base of the brain. *Brit. J. Radiol.*, 1925, xxx, 468–471.

Practically nothing has been written concerning the possibility of recognizing aneurysms of the intracranial portions of the internal carotid area and of the adjacent arteries forming the circle of Willis. During the past ten years, 10 cases have been found in Dr. Cushing's clinic at the Peter Bent Brigham Hospital, Boston. All of these cases were confirmed either by operation or by autopsy, and an equal number of patients has been under observation with presumptive diagnosis of this condition. An analysis of these 20 cases shows striking similarities in the case histories and in the physical findings, but there were no constant roentgenographic signs. This latter fact is presumably due to the variance noted in etiology. About half of the cases were due to arteriosclerotic or degenerative changes in the artery, the rest being embolic or mycotic in origin, occasionally traumatic but never syphilitic.

Suprasellar cysts, gliomas, pituitary adenomas and other tumors, when visible on the films, are rarely confused with aneurysms. The latter may show (1) erosion of a clinoid process or of a lateral half of the sella, clean cut in appearance, and similar to the erosion of the dorsal vertebrae in aortic aneurysm; or (2) calcification in the wall of the aneurysm or in the laminated clot in its sac. These shadows are usually fine, curved lines arising above and just to the side of the pituitary fossa; and they occurred in about one-fourth of the present series of cases. These were all of the arteriosclerotic type. None of the mycotic group showed anything on the roentgenogram, as these aneurysms are small, of short duration, and contain no calcium. A portion of the cases in the series was of unexplained etiology (called by some "congenital"). The roentgenogram in these may show erosion but not calcification. In one instance, the appearance of calcification in the wall of an aneurysm was almost exactly reproduced by a dermoid cyst with a calcified wall. It is conceivable that an echinococcus cyst might occur in this location to give a similar picture.

As yet there is no rational form of therapy for these aneurysms and the prognosis is uniformly bad.

Sperling, Rudolf. The recognition of subphrenic abscess in very early childhood. *Ztschr. f. Kinderh.*, 1925, xxxix, 122–131.

Although subphrenic abscesses during early childhood appear to be great rarities, it is nevertheless believed that many such cases have been observed but have remained unreported. A report is presented of a case occurring in a boy aged fifteen months, the case being of interest because practically the whole course of the disease was under observation in the hospital. The ordinary clinical methods of diagnosis did not permit a definite diagnosis. The roentgen picture in the beginning was negative, and after four days a pleuropulmonary process appeared in the right lower pulmonary field, and four days later a lateral roentgenoscopy showed a high position of the right diaphragm with intensified convexity and reduced motility. The frontal roentgenogram finally permitted a positive diagnosis. This showed a well outlined process below the diaphragm, with indications of considerable extension, and a forward-downward displacement of the liver. The abscess was opened and about 500 c.c. of pus removed; and the child recovered after a short while.

Starck, Hugo. On spasmogenic esophageal dilatations in the roentgenogram. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 504–509.

Dilatations of the esophagus are not common, and they frequently remain unrecognized even in the pronounced case or else they are falsely interpreted. Two forms of dilatation are diverticulosis and diffuse spasmogenic dilatations. Each of these is quite characteristic in origin, location and course.

The pulsion diverticula are always located

on the dorsal wall of the esophagus, always at the level of the cricoid cartilage, and always develop as sac-like projections from the wall of the esophagus. These are definitely recognizable in the roentgenogram and can be easily distinguished by the expert from dilatations above scars or carcinomas.

In spasmogenic dilatations the sole definite etiology seems to be a cramp-like condition of the cardiac section. The condition may begin in one of two ways. The first is a sudden one with severe cramp in the epigastrium or somewhat higher, and the second sets in completely unobserved until the dilatation becomes great enough to give clinical symptoms. In the well-advanced case the attacks of cramps assume the acuteness associated with gallstones and there appear symptoms of stenosis occasioned by the relative closure of the cardiac sphincter. These symptoms alone are sufficient to fix the diagnosis. Esophagoscopy will give definite information regarding the size and shape of the dilatation, the appearance of the mucosa and the cardia. Roentgenoscopy offers the easiest and most direct method of diagnosis and one can observe at once without inconvenience to the patient the outline of the esophagus, its length and diameter, its position in the thorax, its wall thickness, peristalsis and cardia.

The patient is made to swallow a liter of barium paste while standing in front of the screen, observations being made in the dorso anterior and in the first oblique positions. The course of the paste is followed down into the stomach. The stomach filling is peculiar and, as a rule, the stomach itself shows a pronounced hypermotility. Observations would indicate that the cardiac sphincter does not close in a circular manner in such cases but is a narrow slit about 2 to 4 cm. long. Immediately after the roentgenoscopic examination a roentgenogram is taken in the oblique and in the dorso-anterior positions.

Several types of spasmogenic dilatation may be noted. The simplest is the spindle shape. This is rather rare and is probably a very early stage, although it may retain its spindle shape for years. The dilatation begins at the cricoid cartilage, gradually increases in diameter and attains its greatest diameter in the lower third, finally narrowing rapidly toward the cardia.

In the second type the dilatation is uniformly cylindrical from top to bottom. The esophagus does not narrow until just at the diaphragm. The esophagus is lengthened and its lower part tends to curve toward the right but the contours are straight and parallel.

The third type includes a variety of forms, the dilatation taking place in any direction and the effect is observed both in the length and circumference of the esophagus. These are the cases that usually give the most acute clinical symptoms and present great difficulties in treatment.

The form of treatment that appears to offer greatest possibilities for success is overcoming the stenosis of the cardiac sphincter by main force. The author has made use of a dilating instrument, the operation of which is controlled with the roentgenoscope.

STEGEMANN, HERMANN. The visualization of the gall-bladder in the roentgenogram. *München. med. Wchnschr.*, Nov. 20, 1925, lxxii, 1999–2001.

The main advantage of cholecystography lies in the possibility of visualizing the healthy gall-bladder. In the various cases studied by the author in which the gall-bladder could not be visualized the operation invariably showed changes accounting for a negative finding. As a rule, these were due to the blocking of the passage with concretions. One of the disadvantages of cholecystography is that the contrast material used, tetrabromphenolphthalein, is not an entirely harmless substance. The author has observed that a good deal of this disadvantage can be avoided if the dye is administered very slowly and uniformly. This is accomplished by rectal introduction of the dye. The absorption through the large intestine is slow and regular. Hyperactivity of the rectum is controlled by opium. The dye solution is delivered drop-wise, the total amount being 0.12 gm. of sodium tetrabromphenolphthalein per kilo of body weight. The time of administration of the contrast material should be not less than one and a half to two hours. With this technique the normal gall-bladder shadow is visualized in about ten to twelve hours, attaining its greatest density in sixteen to twenty hours. The number of cases thus observed has as yet been very small but the side effects produced by the contrast material were very slight.

STAUNIG, K. Roentgen finding and review of a case of cystadenoma of the trachea. *Wien. klin. Wchnschr.*, Apr. 30, 1925, xviii, 483–484.

A report is given of a case occurring in a woman aged fifty-three years, who appeared for examination because of difficulty in breathing. The roentgen examination disclosed signs of spondylarthritis in the fourth, fifth and sixth cervical vertebrae. The trachea viewed from the front was located medially and showed no signs of displacement or contraction. The lateral view of the trachea showed at the level of the sixth and seventh cervical vertebrae a

mound shaped tumor of fleshy consistency projecting into the lumen from the posterior wall. This tumor had a smooth surface, was about 1.5 cm. high and about 4 cm. in diameter at its base. The lumen of the trachea was narrowed by the growth to a slit 3 mm. wide. No other pathological changes were observed in the thoracic organs.

The tumor was removed and the patient appears to be on the road to recovery. The histological examination of the tissue showed no similarity to thyroid structure. There was no colloid development and no evidence of follicular structure. The tissue presented a net-like, stringy structure of cells in an epithelial arrangement, with cystic spaces between them. These epithelial nests were also observed in the muscular portions of the tracheal wall. The diagnosis was cystadenoma.

The diagnosis of this case was rendered difficult by the fact that in addition to the intratracheal tumor there was present a swelling of the thyroid. This difficulty was resolved by the roentgen examination. The spondylarthritic changes observed in the vicinity of the tumor are regarded as being connected with the latter in the sense that there was an upset in equilibrium caused by the tumor, participated in by these structures.

STEWART, W. H. The time factor in the disappearance of roentgenographic evidence of fracture of the skull. *Brit. J. Radiol.*, 1925, XXX, 399–415.

The completely ossified union of a fractured flat bone like the skull is a comparatively slow process. The connective tissue binding the fragments together gradually changes to an osteoid material, which finally becomes true bone by deposits of lime salts within its structure. As long as complete ossification has not occurred, the fracture line may be recognized roentgenographically. The persistence of this evidence depends largely upon the character and extent of the fracture and upon the position and amount of separation of the fragments.

It is a mistake to make any positive statement as to the length of time required for complete union of a fracture of the skull. Simple fissured fractures of the vault, without comminution, depression or wide separation of the fragments heal the most quickly; because the injury is of a splintering character leaving only simple cracks in the bone without displacement of the fragments. In this class of cases, particularly in young children, it is possible for all roentgenographic evidence of the fracture to disappear within six to eight months. This is illustrated in the brief descriptions given of 3 such cases. In the average adult, simple linear fracture lines remain visible for fully three years. Some cases show a delayed ossification with a peculiar hypertrophic osteitis along the edges of the fractured bones. In the opinion of the author this portion of the bony injury will remain permanently although it may be difficult to recognize the lesion unless one is familiar with the character and location of the original fracture.

If there has been much separation of the fragments the fracture will probably be detectable for three to five years. Shelving fractures, in which the inner table is broken through, not just beneath the outer table, but at some distance from it, disappear more rapidly than those in which both tables are fractured, the inner directly beneath the outer. In exceptional cases one may find a complete union of the inner table, with a wide separation of the outer. In this event the roentgenographic evidence of the fracture will always be present.

Fractures of the occipital, on account of the thickness of the bone are slower to ossify than those of the vault. In adults, without separation of the fragments, it is not uncommon to recognize fracture lines for three to five years. In children, a fracture of the occipital is very common. It may be a simple fissured fracture, but more often there is a considerable separation of the fragments. Persistency of the roentgenographic evidence depends largely upon the amount of separation. Comminuted or depressed fractures of the skull involving the vault are commonly seen. The roentgenographic evidence is most likely permanent, especially if the fragments have not been properly replaced. The undersliding of particles of bone which so often occurs in injuries of this character, if not relieved, can be detected indefinitely. In some cases of fractured skull the bones are so badly comminuted that proper replacement is impossible. The "set-in" fragments often unite with deformity, either by undersliding or turning on edge. The "vacant areas" as a result of these displacements do not always fill in with new bone. The resulting fibrous union is easily recognized for years and will most likely remain a defect for life.

Some of the type of fracture above mentioned are illustrated by 22 roentgenograms.

VALLEBONA, ALESSANDRO. New method of roentgen examination of the digestive tract. *Radiol. med.*, April, 1926, xiii, 241–248.

This new method consists in rendering the inner surface of the walls of the stomach opaque by giving a gelatinous paste of sulphate of barium, or a mixture of this substance with gum arabic, and then distending the stomach by giving bicarbonate of soda in only two or

three teaspoonfuls of water, so as not to wash away the opaque paste. After the barium is given the patient is made to turn in different positions so that the contrast medium will come in contact with all parts of the stomach wall. The patient is first examined standing to show the cardia and body of the stomach and then in left lateral decubitus with postero-anterior projection to show the pyloric region and duodenum. This method shows the folds of the gastric mucosa and the finer structure of the surface of the gastric mucosa as no other method does. The ordinary method shows only the outline of the stomach, while this method gives a deep view of the organ, showing the anterior and posterior walls separately. For this reason peristalsis can be studied much more thoroughly than before. The peristaltic wave is visible directly on both the anterior and posterior walls. Sometimes the two waves are superimposed and then appear as a single line. The old method shows a defect of filling only if it touches, or almost touches, the opposite wall, while this method shows a defect of filling of only one wall, no matter how small. For the same reason a niche of the anterior or posterior wall is visible with this method in posterio-anterior projection.

The passage of the gas into the duodenum and first part of the small intestine can be seen through the walls of the stomach. Sometimes it is necessary to turn the patient a little on his right side so as to dissociate the shadow of the pylorus from that of the spinal column. But generally it is not necessary to turn the patient in this way for when the pyloric region is insufflated it tends to move upward and toward the right side and come into contact with the lower surface of the liver which is clearly visible.

So far the author has used the method only in studying the normal stomach, but he intends to make a later report on pathological conditions of the stomach and intestines.

Vaughan, R. T., and Brams, William A. The diagnosis of ruptured gastric and duodenal ulcer in the early stages by visualization of free intraperitoneal air on fluoroscopy. *Wien. med. Wchnschr.*, Aug. 15, 1925, lxxv, 1913–1915.

Free air in the peritoneal cavity was found in 13 out of 15 cases of acutely perforated peptic ulcer examined roentgenoscopically without preparation of the patient or use of a contrast meal. The free air is an early sign, and it was seen as early as two hours after the onset of the first symptom and before the clinical picture had opportunity to develop.

The free air manifests itself by a clear zone which tends to collect in the uppermost regions of the peritoneal cavity, depending upon the position of the patient. Fluid may also be observed when present by noting a straight horizontal line; and a splashing movement may be observed if the patient is shaken during roentgenoscopy. While the sign is not limited to the occurrence of perforated gastric ulcer and may occur in perforation almost anywhere in the gastrointestinal tract, the authors believe the sign to be of value in view of the relative frequency of gastric and duodenal perforation as compared with others. Perforation elsewhere in the gastrointestinal tract is also a surgical condition, demanding immediate care, and the sign is therefore not of less value in diagnosis of such conditions. The earlier recognition of perforation permits earlier operation, and this no doubt will be a very important factor in improving the prognosis in acute perforation of peptic ulcer.

Verbrugge, Jean. Gastrojejunocolic fistulas. *Arch. Surg.*, November, 1925, xi, 790–808.

In this study, there are 216 cases of gastrocolic and jejunocolic fistulas. Of this total, 202 are compiled from the literature (including 7 observed at the Mayo Clinic) and 14 are new cases reported from the Mayo Clinic. In 95 the condition was the result of the duodenal ulcer which developed following posterior gastroenterostomy, and in 121 it was the result of primary abdominal organic lesions.

Of the total of 21 cases observed at the Mayo Clinic, 2 were associated with carcinoma of the colon, and 19 were the result of a gastrojejunal ulcer which developed after posterior gastroenterostomy. All the patients were males, varying in age from twenty-seven to sixty-four years. The etiologic factor in the second group was duodenal ulcer in 16 cases, gastric ulcer in one, atony of the stomach in one, and in the remaining case the primary disease was unknown.

The symptoms of the fistula could not always be distinguished from those of the duodenal ulcer, but in 2 cases diarrhea was the first symptom. The duration of the period of relief following gastroenterostomy varied from three months to ten and a half years, the average duration being three and a half years. The outstanding symptoms were diarrhea (13 cases), fecal vomiting (11 cases), pain (9 cases), and visible peristalsis (1 case). Operation was performed in 20 cases; in 4 cases partial resections of the transverse colon were made; in 15 the fistula was closed; in 11 the old gastroenterostomy was cut off; in 4 a new one was made; in 2 the old gastroenterostomy was re-established; in 3 partial resection of the jejunum was

performed; in 2 pyloroplasty; and in one jejunostomy and cecostomy. Five patients died, 2 following the resection of the colon for carcinoma, one from acute nephritis two years after operation, one from general peritonitis and bronchopneumonia, and one from indefinite cause. One patient refused operation and has not been heard from since. The other 15 patients recovered and none has complained of definite symptoms of recurrence. The 14 new cases are briefly cited.

Roentgen-ray examination was made in 20 of the series of 21 cases; it was positive in 11, doubtful in one case and negative in eight. The roentgen-ray findings are: irregular contour of the stomach; signs of perigastritis with limited mobility of the stomach; passage of bismuth into the colon; presence of bismuth in the descending colon and sigmoid; possibility of provoking the passage of bismuth from the colon into the stomach by palpation, and presence of bismuth in the stomach following a bismuth enema.

VESPIGNANI, ARCANGELO. Inclined position for the roentgen examination of the stomach and duodenum. *Radiol. med.*, April, 1926, xiii, 272–281.

Vespignani describes an inclined position intermediate between right lateral decubitus and the upright position, which is useful in examination of the stomach and duodenum. It may be used with ventrodorsal or right anterior oblique projections. The patient lies on his right side on the table and supports himself in a semi-upright position on his elbow or on his hand with the arm extended. The angle of inclination may be varied by changing from elbow to hand or vice versa. This position is particularly valuable in the examination of lesions of the pyloric antrum and the bulb of the duodenum which do not show up well in the ordinary positions. In atonic and elongated stomachs the antrum and bulb do not fill well in the upright position and cannot be seen, and in the prone position the shadows of the antrum and bulb are often superimposed so that a clear picture is not obtained. The inclined position rotates the organs a little so that the shadows of the antrum and bulb are detached and details show up clearly. Moreover they fill readily without resorting to pressure which is necessary in the upright position and which may alter the tonus and motility of the stomach and duodenum. Roentgenograms are given showing clearly niches or incisures of the posterior wall of the bulb of the duodenum can be brought out.

VIETTI, MARCO. Roentgenological appearance of taenia. *Radiol. med.*, April, 1926, xiii, 282–287.

All the roentgen reports of intestinal parasites have dealt with nematodes. The author describes 3 cases of tapeworm which he demonstrated roentgenologically and discusses the differential diagnosis from round worms. One of the differential points is the greater length of the taenia. This cannot always be demonstrated directly, for the whole length of the worm is not always visible, but it can be deduced from the absence of the pointed extremities which are characteristic of round worms. The very difficulty of demonstrating them roentgenologically is an argument in favor of taenia. Tapeworms do not give that impression of roundness given by the varying thickness of the ascarids and by the opaque substance which surrounds them. The taeniae are less elastic, as is shown by the fact that the curves are less rounded, or even sometimes almost wholly flattened out, which never occurs with ascarids, at least as long as they are alive. There is reason to believe that the rather sharp angles of the outline of the taenia are due to its segmented form, and sometimes to a torsion on its axis of the ribbon-like body of the parasite. The outlines are not so sharp as those of the ascarid, nor are they so perfectly linear; they sometimes show slight angularity resulting from the jointed structure of the parasite, so that the picture of a taenia has the appearance of a chain, rather than that of a rod like the ascarid.

VINSON, PORTER P., and SUTHERLAND, C. G. Esophagobronchial fistula resulting from actinomycosis: Report of a case. *Radiology*, January, 1926, vi, 63–64.

A report is given of a case which is interesting primarily because of an actinomycosis that had been actively present for twenty-eight years. There was a wide distribution of the lesions and development of an esophagobronchial fistula was a most unusual complication. The woman aged thirty-seven, was given a general examination at the Mayo Clinic. There was a healed scar on the left leg just below the knee. On the left side of the chest in the region of the fourth and fifth ribs in the anterior axillary line there were several draining sinuses and one healed scar. The skin on the entire chest was tanned by previous exposure to roentgen rays and sunlight (she had received roentgen-ray treatment the preceding year when the diagnosis of actinomycosis was first definitely established). Smears from the

septum and from the sinuses in the chest revealed actinomyces.

The roentgenogram of the chest showed marked increased density through the lower left periphery, extending to the second rib, which was interpreted as an inflammatory lesion. The blood Wassermann reaction by the Kolmer technique was weakly positive but this was not confirmed by a second examination, and it was concluded that a deep seated actinomycosis was reponsible for the serological findings. Roentgenoscopy revealed an esophagobronchial fistula but nothing abnormal was found on examining the stomach. On the left side at the level of the sixth rib posteriorly, barium was seen entering the bronchus. There was marked scarring of the posterior pharyngeal wall, and loss of almost the entire left vocal cord, with scarring extending into the subglottic region.

Because of the excellent general condition of the patient and the remarkable acquired resistance to the infection, treatment of any type was not deemed advisable and she was therefore dismissed from observation.

Walter, Hermann. The development of a pseudarthrosis in dystrophia musculorum progressiva, and its course. *Arch. f. klin. Chir., Berl.*, 1926, cxxxix, 574–580.

Osseous growth disturbance in progressive muscular dystrophy is known to occur, although rather rarely. Neither the relationship nor the cause of the disturbance is understood as yet. A case is described occurring in a stonecutter nineteen and a half years old. He had been unable to use his right arm in customary work for the preceding six months, and there had developed a swelling of the right forearm to the size of a goose egg. The rest of the history was unimportant.

The roentgen examination, which included the whole skeletal system, showed a rather slender structure of the bones, and very definite calcium poverty. The epiphyseal lines were intact everywhere and some of them very broad, corresponding to those to be found at fourteen years of age. There was also a Schlatter's projection on both tibias. There was also a broad projecting processus posterior tali, and and in the epiphysis of the basal phalant of the right small finger there was a fracture of the radial half with dislocation and a rarefaction in the subjacent spongious bone. The swelling on the right ulna was seen in the roentgenogram to be a spindle shaped osseous body with longitudinal structure beginning below the coronoid process, showing its greatest diameter at the boundary of the upper and middle thirds and gradually decreasing in diameter toward the distal end. The swelling was uniform circularly and was quite distinctly separated from the external boundary of the cortex. Through its thickest portion there passed a transverse zone of rarefaction, this calcium-deficient to calcium-free zone having faint and irregular boundaries. The shaft of the ulna at this point likewise showed rarefaction. There was however, no fracture or fissure so far as could be determined clinically. The marrow space was continuous throughout the length of the bone, although there was a distinct bend in the axis at this point. The swelling was well outlined and showed no destructive infiltration into neighboring tissues.

The roentgenogram shows that this is not a real tumor, but rather a periosteal bone proliferation with a pseudarthrosis-like rarefaction in the periosteal callus above the atrophying diaphysis of the ulna. A piece of the tissue was excised, and the histological exmination confirmed the diagnosis. The split was found to be filled with connective tissue and the surface was covered with cartilage which contained bone trabeculae. There was no sign of tuberculosis, syphilis or osteitis fibrosa. Apparently the condition was due to an old fracture followed by pseudarthrosis.

The condition receded under exposure to the sun in conjunction with passive manipulations.

Wentworth, Edward T. Systematic diagnosis in backache. *J. Bone & Joint Surg.*, January, 1926, viii, 137–170.

Systematic search reveals discriminating objective evidence of many distinct lesions. Only very few cases leave "injury" out of the history. As a rule, histories of radiating pain are inaccurate and of little differentiating value as compared with subjective location of constant pain. Sciatic pain is not necessarily sciatica, but may be. Exaggeration is as common as malingering is rare. Spinal deviations are of little or no differentiating value. Posture, including the feet, is an important element in static backs and static sacroiliac strains. The flat lumbar spine is common in sacroiliac subluxation. Marked limitation in spinal flexion must be present to be of differentiating value; and the age factor must always be borne in mind when considering range of spinal flexibility.

Pain in the back on straight leg raising must occur before the extremity reaches 135° to be of much differentiating value. After that almost any low back pain will be aggravated. Pain on thigh hyperextension has no differentiating value. Audible clicks are not pathognomonic of sacroiliac relaxation.

Subluxation is a more severe lesion than

strain, and it has more direct relationship to trauma and quicker pain reactions to manipulations. Pain on crest compression is limited to sacroiliac cases but is not always present in them. Roentgenography is absolutely essential in any complete differential diagnostic procedure. Altered reflexes, muscle atrophies and paralyses, localized clonic contractions, trophic changes, areas of decreased or altered tactile sensibility and hyperalgesia are important in neuritis, perineuritis, radiculitis, and nerve injury, but not in bone and joint lesions. The diagnosis of fractures, dislocations and osteoarthritis may be finally established by the roentgenogram. The diagnosis of sacroiliac subluxation may be proved by a manipulative reduction. The differentiation between lumbosacral and sacroiliac strains, after all, depends upon a very few findings: location of the pain and tenderness, occupation, pain on straight leg raising between 180° and 140° and of crest compression. Roentgenography may be of value but is not essential.

Cases of traumatic strain limited to lumbosacral or to sacroiliac ligaments are rare. In most cases of traumatic strain both sets of ligaments are involved. The diagnosis of static strain depends upon absence of definite lesions in the presence of poor physical condition or bad body mechanics. Congenital bone anomalies of the lumbo-sacro-iliac region may be contributory factors in many lesions, but the physiologic balance maintained by muscles and ligaments is of more importance than the anatomic bone structures.

Logic and the preponderance of evidence at present are against sacralization and large transverse processes as the etiologic factors in back pain, except through unusual leverage action and consequent ligamental strain.

ROENTGEN AND RADIUM THERAPY

Walter, K., and Lax. The roentgen treatment of trigeminal neuralgia. *München. med. Wchnschr.*, Apr. 16, 1926, lxxiii, 643–645.

Despite the fact that trigeminal neuralgia offers such great difficulties in treatment, it seems remarkable that very little has been done in the employment of roentgen rays for this condition, although the sedative effect of the rays has been known for a long time. As far back as 1900, there appeared a paper by Stembo wherein was reported the favorable effect of roentgen rays on neuralgias.

The authors first began to give occasional treatments in 1921, and since 1923 they have systematically treated with roentgen rays all cases of trigeminal neuralgia at the Neurologic Clinic of the University of Rostock. The total number of cases reported on is 30. A number of them had previously received surgical treatment (alcohol injections). The roentgen rays were applied so as to reach the gasserian ganglion. The first dose was administered through the temple of the involved side, and where a second irradiation was necessary the portal was through the other temple. The first cases received a certain amount of irradiation over the cheeks, but in the past two years the cheeks were carefully screened since it appeared that their irradiation was unnecessary. The dose administered was one-third of the skin erythema dose.

The number of irradiations administered in this series varied from one to nine. Most of the cases showed an acute reaction after the irradiation in the sense that the neuralgic pains were very much increased; this reaction was absent in only 11 of the cases. After several days this pain diminished, and gradually definite improvement set in. This pain reaction returned after succeeding treatments even though improvement had occurred previously.

Amongst the cases showing no reaction 4 were completely cured and 2 have remained more or less refractory. Among the 19 cases showing the pain reaction after irradiation, there were 15 cures and 4 considerable improvements (one doubtful). This seems to indicate that an acute pain reaction is in general prognostic of a favorable ultimate response.

Seventeen of the cases had received no previous treatment and these after roentgen therapy showed 13 cures, 3 considerable improvements and one refractory case; 13 of the cases had previously received alcohol injections, and these after roentgen treatment showed 6 cures, 3 considerable improvements, 2 improvements and 2 doubtful. This seems to support the belief that previous operation or injection has an unfavorable effect on the outcome of the cases when subjected to roentgen treatment.

Application of roentgen treatment to other forms of neuralgia have thus far proven unsuccessful in the hands of the authors.

Borak, J., and Driak, F. Melanin excretion following roentgen irradiation of melanosarcomas. *Klin. Wchnschr.*, March 5, 1926, v, 411–412.

Lenk reported a case of melanosarcoma in which radiation therapy caused a pronounced excretion of melanin in the urine. To confirm this observation and to determine the causal

relationship between irradiation and melanin excretion the authors made a study of 3 cases, which are reported.

It was found that roentgen irradiation of melanosarcomas produced within twenty-four or forty-eight hours a urinary excretion of melanin or melanogen lasting two to five days. The roentgen dose causing this effect was 15 H (equals 125 per cent of the skin unit dose) through 4 mm. Al. Doses of 10 H were without effect.

Little as yet can be said as to the mechanism involved, except that the inside or outside of the cell undergoes a reduction to the colorless melanogen which is excreted in the urine. In one case a repeatedly irradiated nodule was examined histologically and no cell injury could be demonstrated, although that portion of the tumor which faced the roentgen tube appeared definitely paler than the opposite side. It may be mentioned that the tumors did not decrease in size as a result of the treatment, and the decolorized nodules remained pale up to the time of death of the individual, thus indicating that the pigment-forming capacity of the cells had been injured. In another of the cases it was observed, however, that although the pigmented tumors remained uninfluenced, those poor in pigment or unpigmented did decrease in size after irradiation.

It would seem therefore that there exists a relation between the radiation sensitiveness and the biological character of certain cell functions in the sense that the most active biological function represents also the most radiosensitive. These observations also show that the roentgen rays do not always affect the generative activities of cells; but frequently a single cell function may be the only one involved when life is not destroyed.

FORSCHNER, L., and REGNIER, E. The roentgen therapy of othematoma. *Strablentherapie*, 1925, xxi, 91–95.

Roentgen therapy of othematoma is the therapy of choice, since it may be applied without inconvenience to the patients and avoids surgical treatment. Moreover, the cosmetic effect is excellent. In old cases in which there has already occurred a thickening and deformation of the auricle, the customary surgical methods still are applicable since the roentgen rays, although able to prevent deformation, are unable to correct existing deformity.

Two cases are cited briefly. The irradiation technique is simple. The involved ear receives a dose of 3 H filtered through 3 to 4 mm. Al, care being taken to cover adjacent surfaces with lead rubber. Great weight is laid upon the maintenance of this dose, since the effects obtained with other doses have not been nearly so good. So far as concerns injury to the cartilage, it is stated that none has been observed after the employment of the above dose. In those cases in which the othematoma has diminished by a half in four days, there is no need for a second irradiation, as the complete cure is obtained after about four weeks, with excellent cosmetic effect. In those cases, however, in which regression is not so prompt, a second treatment four weeks after the first should be given. In only one case in the authors' experience was it necessary to give three treatments to obtain the desired effect.

Among the 23 cases treated, a poor result was obtained only twice. The first was one of the earliest cases and failure was probably due to poor technique. The second case was in a patient who disappeared after the first treatment to return three months later with a new, infected othematoma. This was promptly controlled but the cosmetic effect was not so very good.

FORSDIKE, SIDNEY. The treatment of severe and persistent uterine haemorrhage by radium. *Brit. M. J.*, March 13, 1926, i, 472–475.

A report is given on 200 cases of so-called idiopathic or essential hemorrhage, that is, excessive and uncontrollable hemorrhage with the absence of any pelvic lesion to account for it. This series does not include the minor uterine hemorrhages which are relieved by drugs or a single curettage, but only cases which had been dealt with in the ordinary way and proved refractory. There was in addition an advanced degree of anemia with shortness of breath, headache, edema of the legs, etc., and the patient had to spend some part of each month in bed on account of the severity of the hemorrhage.

The condition is commonly found at and around puberty, between thirty and forty years of age and at the menopause. The clinical picture is that of menorrhagia or metrorrhagia. It is not believed that syphilis plays any part in the etiology. Clinically two types of uterus are met with in this condition: the systolic and the diastolic. The systolic uterus is but slightly if any larger than the normal organ, is hard, heavy and regular in outline with a cavity 2.5 to 3 inches long. It yields little or no tissue to the curette, and on section the wall may be as much as an inch in thickness, and the arteries are prominent with gaping mouths, quite incapable of collapse.

The diastolic uterus is bulky and retroverted, with a cavity between 3.25 and 5 inches long, and yields a considerable quantity of thickened edematous tissue to the curette. It is a condition which is almost certainly cured by exposure to radium. In the present series 32 per cent had the systolic uterus and 60 per cent the diastolic. The diagnosis must necessarily depend upon the result of an exploratory curettage, the exclusion of new growths, the absence of any other pelvic lesion which would induce hemorrhage, and upon the physical characters of the uterus as determined bimanually and by the curette.

In nearly all of 128 cases at or near the menopause one dose of radium sufficed to establish amenorrhea. Three cases required two treatments and one three exposures. Of all the 200 cases, 7 per cent required two exposures and 3 per cent required three exposures before menopause was induced; but they occurred for the most part in younger women. All the cases which were refractory to a single treatment occurred in young women. Thirty cases were complicated with fibroids, all small in size, some of which were diagnosed only by the curette; and which did equally well as the non-fibroid cases.

Whatever treatment is adopted for this condition, anesthesia is required for an imperative exploration of the uterus, and the radium in suitable cases is introduced at the same time. Where a second or third exposure is required, the radium may be introduced into the uterus without another anesthetic after softening the cervix with glycerin plugs. In all cases dilatation of the cervix and an exploratory curettage are done, and any tissue removed is referred for microscopic examination. The radium is screened with brass or lead to filter out all but the gamma rays, and the tube is then surrounded with rubber 2 to 3 mm. thick to exclude secondary rays. After insertion of the radium, the vagina is plugged with gauze soaked in liquid paraffin, with the object of keeping the radium in position and the bladder and rectum as far away as possible from the radium. A further precaution is the insertion of a self-retaining catheter in the bladder.

The correct dose cannot be stated since it is adjusted to the individual case. In women at or near the menopause 100 mg. radium bromide in 0.5 mm. silver and 1 mm. brass or lead wrapped up in rubber 2.3 mm. is given for twenty-four hours and is commonly successful, but if it is of urgent importance to stop hemorrhage the radium may be left in for thirty-six or even forty-eight hours. For fibroids the author gives a minimum exposure of thirty hours. These doses invariably prove satisfactory, and a second treatment is rarely required.

The ground is much less certain in the treatment of young women. In urgent cases the author administers 100 mg. for twenty-four hours, which establishes amenorrhea for a short time only.

While the radium is in the uterus some pain is produced from the contraction of the uterus in the effort to expel the foreign body. In sensitive patients this may require administration of a sedative. Vomiting may be a pronounced symptom which never becomes serious and ceases abruptly with the removal of the radium. There is a small rise of temperature to 100° which persists for a day or so. Commonly there is a prolonged menstrual flow for two or three weeks followed by a second one after which amenorrhea sets in. A certain number will experience a third period. Generally speaking three months must elapse before the full results can be estimated; and if hemorrhage persists beyond this, further treatment will be necessary. Leucorrhea invariably follows the treatment and in some cases produces irritation of the vulva. This disappears in about six weeks, but in cases complicated with a fibroid the discharge may last longer.

There is not infrequently a complaint of painful micturition which is probably due to irritation caused by the catheter in the bladder.

The sole absolute contraindication to the use of radium in this condition is the presence of pelvic inflammation, and this is a real danger. Relative contraindications are patients bled white through loss of blood where the red blood count is reduced by one-half, the leucocytes increased by one-half and the pulse and temperature warn that the patient is at a low ebb. The chief causes of late recurrences are (1) septic foci, pyorrhea, etc.; (2) cystic ovaries; (3) pelvic inflammation, and (4) high blood pressure associated with contracted kidneys.

FRIED, C. Roentgen therapy of postoperative pneumonia. *Klin. Wchnschr.*, Jan. 1, 1926, v, 15–18.

A report is given on the results obtained in the radiation treatment of 40 cases of postoperative pneumonia. The results were excellent in 20 cases, good in 12, doubtful in one and negative in 7. The negative cases did not die, the irradiations simply produced no immediate visible results. Only one of the irradiated cases died (pneumonia following gastric resection).

The effect of the rays is shown in three ways: drop in temperature, improvement of the local symptoms and of the subjective condition. These effects are very striking and usually appear within twenty-four hours after treat-

ment; in certain cases the improvement became evident in six and twelve hours. Several typical cases are cited. This success was obtained both in bronchopneumonias and lobar pneumonias. Three out of 4 cases complicated by pleuritic exudate were successfully irradiated.

Incidental radiation treatment was given in some non-operative pneumonias and the results were satisfactory in a majority of the cases, 2 of which are briefly cited. There were 3 cases of non-operative tuberculous pneumonias. Two of these were of the caseous type and did not respond to the radiation treatment; the third was an indurative tuberculous pneumonia and showed good response.

The success of this particular form of therapy depends very largely on careful dosage, and adjustment of the dose to the constitution and general condition of the patient at the time of treatment. The initial dose varied between 80 and 120 R upon the skin (in children down to 50 R), filtered through 0.5 mm. Zn and 0.5 mm. Al, 140 kv., 8 ma., 50 cm. focal skin distance. The exposure was made over one large portal covering the whole lung field or, where necessary, over both lower lobes. The employment of a large field and long focal distance seems to be particularly advantageous in the treatment of pneumonias.

This treatment was first given only to pneumonias that appeared to have become stationary; later the treatment was applied in the acute stages of the disease; more recently the radiation therapy has been applied in the initial stages of the disease, and in these cases the impression was obtained that dangerous outcome was avoided.

JESSNER, MAX. The therapy of roentgen telangiectasis. *Klin. Wchnschr.*, Feb. 12, 1926, v, 270–271.

The mildest form of roentgen injury of the skin is found in the more or less numerous telangiectases with or without mild atrophy. This condition is stationary and comes up for consideration only in cases involving cosmetic effects.

Formerly the author recommended to his patients the use of a 2 per cent ichthyolmitin paste containing 5 per cent oil, which was to be warmed and then applied in a thin layer over the affected area. This was then to be covered with a yellowish-brown powder, the tint of which was to be adjusted to the individual's complexion. The patients eventually learned how to apply and tint the preparation so as to yield a highly satisfactory coating.

Since 1922 thirteen cases have been treated with doramad salve; 8 were cases of telangiectasis following cervical gland irradiations, 2 after thyroid irradiations, one after postoperative irradiation of cancer of the breast and one on the back. The doramad salve (containing 2000 E.S.U. per gram of salve) was given in six applications of twenty-four hours each at intervals of six to ten weeks. Two of the patients received but one treatment and were lost from observation. In all the others a very good result was observed after the third to fifth treatment. The telangiectases became considerably paler and in some had contracted to more or less large completely normal islands. The reactions occurring in the first days after the doramad application were medium and apparently never as pronounced as in other conditions. An injurious effect of the treatment was observed but once in a woman who, despite strict orders to remove the salve after twenty-four hours, permitted it to remain for eight days; and in this case there resulted an erosion which lasted four weeks.

Care is recommended in the use of this form of therapy especially as regards the number of treatments since there is a possibility of over-irritation of the irradiated area.

KORBSCH, ROGER. The roentgen therapy of chronic gastritis. *München. med. Wchnschr.*, Feb. 19, 1926, lxxiii, 317–319.

Many observations seem to indicate that in the subacid form of chronic gastritis the pathologic process seems to be in the upper portion of the stomach and the fundus, while in the hyperacid type, it is usually in the lower portion and the antrum, where, it is suspected, there exists not only a control center for tonus and peristalsis but also for the secretion of the whole organ. The clinical observations also show that the hyperacid types of gastritis are peculiarly obstinate and tend to undergo complications. This peculiarity of the chronic inflammatory process suggested the application of radiation therapy.

The early experiments with roentgen therapy showed a favorable effect upon subjective symptoms and in the gastroscopic findings.

A detailed description is given of a case in a young man, aged twenty-five. The severe chronic gastritis remained unchanged despite the usual treatment, and roentgen therapy was tried in conjunction with gastric lavage. Four treatments were given at intervals of three to four days. Each treatment consisted of one-fourth of the skin unit dose, 27 cm. skin focus distance, filtration through 0.5 mm. Zn plus 3 mm. Al. The epigastric region was irradiated so as to reach the caudal portion of the stomach which was the seat of disease. Two days after the last treatment a gastro-

scopic examination showed a remarkable change in the diseased gastric mucosa. The motility appeared more normal, the mucosa of the antrum had lost most of its inflamed appearance, although it appeared somewhat thickened. At the site of the original ulceration there was to be seen only a slight contraction of the mucosa. The fundus still showed signs of inflammation. The subjective state was very much improved after the second irradiation. There can be no doubt from this example that the radiation therapy was definitely effective in this type of gastric disease.

Levy, Robert L., and Golden, Ross. Roentgen-ray therapy in rheumatic heart disease. *Proc. Soc. Exper. Biol. & Med.*, February, 1926, xxiii, 351–353.

No method is known whereby cardiac involvement in rheumatic fever may be effectually prevented. Nor has it been possible significantly to modify the progressive character of the lesions initiated in the heart structures by the rheumatic process. These lesions are of two kinds: exudative, and proliferative.

There are reasons for believing that roentgen rays might exercise an effect upon the rheumatic heart lesions in the sense of increasing local resistance to invading organisms and in a softening action upon scar tissue. Possibly the physical condition of thickened, stiff valve leaflets might be altered. However, the dose necessary to modify cicatricial tissue is greater than that used in the treatment of infections and the time required for the change to appear is much longer.

A preliminary report is given on the results obtained with roentgen therapy in 6 cases of rheumatic heart disease. Two of the cases have been followed for nine months. The precordium was irradiated through a portal depending upon the size of the heart (usually 15 × 15 cm.). The factors were 200 kv. peak, 50 cm. target skin distance, 4 ma., 0.5 mm. Cu plus 2.0 mm. Al. The thickness of the left side of the chest was measured with a pelvimeter, and the dose determined with the aid of anatomical and isodose charts. It was calculated to yield about 10 per cent of the theoretical erythema dose in the region of the mitral valve. This dosage is relatively small, but it was necessary in order to avoid possibility of cardiac injury.

In 3 cases definite and marked clinical improvement has been observed coincident with changes in the form of the electrocardiogram.

The alterations in the forms of the electrocardiograms following roentgenotherapy have been of three main types: (1) alteration in the form and direction of the T waves; (2) change in the form, direction and notching of the Q.R.S.; (3) change in the duration of the P-R time, when this was prolonged. In two instances occasional ventricular beats appeared following exposure to the waves. The irregularity was transitory but was regarded as noteworthy in that it was not observed in many other records. The significant fact is the direct relationship of the electrocardiographic characteristics to the radiation therapy, and their association with clinical improvement. This suggests that an influence, presumably favorable, has been brought to bear on the lesions in the heart muscle.

A limited number of roentgen-ray treatments have been given to 2 patients with *Streptococcus viridans* endocarditis without evident effect either on the course of the disease or on the electrocardiogram.

Milligan, William. Radio-diathermy in the treatment of inoperable malignant disease of the upper air and food passages. *Brit. M. J.*, Feb. 27, 1926, i, 364–367.

Diathermy is of definite value when ordinary surgical procedures are contraindicated; its use is followed by little, if any, shock, and with reasonable care in application it is a practically bloodless operation. Besides sterilizing the tissues, it blocks the vascular and lymphatic channels leading to and from the growth and thus tends to prevent dissemination of the cancer cells. Diathermy affords relief from mechanical symptoms such as obstruction, dyspnea, etc., and arrests the tendency to spontaneous hemorrhage. It relieves pain and the resulting scar tissue is soft and pliable and does not form adhesions. Septic bronchopneumonia appears to be less frequent after diathermy than after severe cutting operations.

One of the disadvantages of diathermy is that it destroys a certain area of healthy tissue around the original growth. Moreover the walls of blood vessels in the immediate neighborhood of the growth may become softened and ulcerated with resultant attacks of severe secondary hemorrhage. Whenever the skin is involved keloid cicatrices may develop.

The advantage of combining the application of radium with coagulation by diathermy is that the lymphatic area is thereby irradiated, wandering malignant cells are killed off, and the risk of subsequent metastases is materially lessened. The results obtained by radio-diathermy, complicated and tedious as the treatment undoubtedly is, will repay all the trouble taken. The patient frequently takes on a new lease of life, becomes free from pain and

hemorrhage and in most instances continues with greater comfort than would otherwise have been the case.

Cancer of the floor of the mouth is peculiarly amenable to diathermy if care is taken to coagulate thoroughly around the growth until all indurated tissue has been destroyed. Malignant growths involving the tonsil, the palatine arches and frequently invading the base of the tongue are not uncommon and from a surgical point of view are usually inoperable, in which case there is almost invariably much infiltration and fixation with extensive glandular involvement in the superior carotid triangle. Epithelial growths in this locality are very radioresistant, hence the combination of diathermy and irradiation is useful. The infected glands are first removed after ligature of the external carotid artery, followed in ten days to a fortnight by ligature of the other external carotid artery and coagulation of the primary seat of disease. Free access to the malignant growth may necessitate a subperiosteal resection of the angle of the inferior maxilla. This permits complete removal of enlarged glands, and the growth may be treated from the inside by coagulation and from the outside by irradiation. Ultimate success can be obtained only by employing heroic measures.

Irradiation may be effected either by burying needles along the route of the lymphatic stream leading from the focus of disease, by means of applicators applied around the angle of the jaw, or by a combination of both methods. The results are at times surprisingly good, several of the author's patients having had complete freedom from symptoms for three to five years.

In the case of laryngeal cancer the position of the growth, its size and anatomical relations help to determine the particular route of approach. The author advocates the more frequent performance of a laryngo-fissure, for the reason that many growths both extrinsic and intrinsic are thereby rendered more visible. There is a distinct limit to what electrocoagulation and radium treatment is capable of accomplishing. If the glands are non-adherent and can be removed, the lymphatic avenues leading to them should be thoroughly irradiated after coagulation of the primary growth. This is best done by insertion of six to eight tubes containing 5 to 10 mg. radium along the lymphatic stream. Better results are obtained by implanting radium needles within the tissues than by applicators applied to the surface. When it is decided to rely on radium alone, a useful plan is to resect a portion or the whole of the thyroid ala and through the fenestration to nsert with precision into the growth a varying number of tubes, and subsequently to fix a casted radium applicator around the neck.

In the case of malignant growths of the antrum and ethmoidal labyrinth the steps to be followed are as follows: (1) ligature of the external carotid artery; (2) removal of glands; (3) exposure of antral or ethmoidal growth by external incision; (4) curetting of the growth; (5) application of diathermy with the button electrode; (6) surface application of radium.

Carcinoma of the nasopharynx presents a problem of great complexity. Sarcomas yield fairly readily to treatment with radium alone, the number of needles and the dosage varying with the size and structure of the tumor. This cannot be accomplished with carcinomas. There should be no hesitation in thoroughly removing any tissue hard or soft in order to gain proper access to the growth. Several applications may be necessary to coagulate even a small growth owing to the mechanical difficulties involved.

Cancer of the hypopharynx, which is not uncommon in females, is amenable to diathermy provided the disease is high up and strictly localized. Malignancy of the esophagus at the bifurcation of the trachea makes it difficult to ascertain the degree of mural involvement and the risk of perforation. Consequently diathermy in this position is always dangerous. A preliminary coagulation and consequent opening up of the stricture permits a subsequent irradiation with screened radium. In all cases the performance of a preliminary gastrostomy is advisable. In the case of carcinoma of the thoracic esophagus, diathermic coagulation with or without subsequent employment of radium offers a very slight chance of eradicating the disease.

Rochlin, D. G., Schirmunsky, Klaudia, and Kotschneff, Nina. Certain characteristics of the constitutional picture in individuals suffering from psoriasis. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 961–970.

A preliminary report is given on the observations made in 30 cases of psoriasis. The authors arrive at the conclusion that the disease finds its origin in a peculiar constitutional condition of the organism. The observation of other authors is confirmed as regards the relation of psoriasis to disturbances of the thyroid, and of the female sex glands. Attention is also directed to the rôle of another endocrine gland, the hypophysis. The sella turcica has been found practically always in this disease to lie at the upper limits of the normal, and the skeleton of the hand often shows an acromegaloid structure. The blood sugar content is usually very much decreased (30 per cent on the average). The calcium content of the

blood was found to be normal. Brief descriptions are given of some of the cases.

SCOTT, S. GILBERT. Method of treating asthma by radiation. *Brit. M. J.*, June 5, 1926, i, 939-941.

A preliminary summary is given of the beneficial effects thus far obtained in asthma by means of irradiation. The treatment was given in 21 cases, and the time is yet too short for any statement as to the permanency of results; but the treatment has proven a valuable palliative agent. Irradiation attacks this distressing complaint from a new angle, the theoretical basis of which is unknown. Apparently the influence of the radiations on asthma is a complex matter, probably not due to a direct influence on the lung tissue, but rather to some profound indirect or secondary change affecting the whole body.

The dosage required is small, namely 10 X through 3 mm. Al., and the voltage should be low. Emphasis is placed on the necessity for exposing practically the whole trunk. Irradiation of the thorax alone does not give any results. The use of two tubes simultaneously one in front and one in back saves time. This dual dose of 10 X through 3 mm. Al measured on the skin is administered once a week in the average case, and twice a week if the case is severe. After the fourth dose an interval of two weeks is allowed and then it is repeated once a month for four months. After that the patient is instructed to report as soon as any wheezing or "tightness" of the chest is noticed, when a further dose is given.

Practically all the cases so far examined have had a definite fibrosis of the roots of the lungs, but whether this is the cause or effect is unknown. The immediate effects of the treatment are experienced within a few hours. The tightness in the chest is relieved and the sputum is more productive. So far all patients treated have obtained very definite relief. A definite increase in weight in most cases is an interesting secondary effect noted.

Of the 21 cases of chronic asthma of various types so far treated by irradiation over a period of two and a half years, all except the two youngest had tried every other form of treatment with little or no benefit.

SIELMANN. The radiation therapy of hyperthyroidism. *München. med. Wchnschr.*, March 12, 1926, lxxiii, 439-451.

Diseases of the thyroid are amenable both to operation and to roentgen therapy. An experience of twenty years in Munich with a careful analysis and comparison of the results following operative and roentgen therapeutic treatment enables the author now to decide in practically every case whether operation or roentgen treatment will be most desirable.

The surgeon should treat all nodular and cystic degenerated thyroids and cases of Basedow's disease having large strumas and showing pressure symptoms. The parenchymatous form in young persons is best amenable to roentgen therapy. All cases of hyperthyroidism, especially Basedow's disease, should be primarily (not after the failure of internal remedies) the domain of roentgen therapy since the results are at least as good as those after operation, with the advantage that the treatment is less dangerous. Should the radiation therapy fail the case may still be turned over to the surgeon without detriment. Since such refractory cases do not always respond to surgical treatment, they should receive postoperative irradiation, which is occasionally successful.

Roentgen irradiation is the therapy of choice in malignant struma because surgery is entirely helpless, and roentgen therapy often produces extraordinarily favorable results. Roentgen therapy of thyroid conditions which has been practiced with success in other countries has not found wide application in Germany.

THEDERING. The dead point in radiation therapy. *München. med. Wchnschr.*, Feb. 19, 1926, lxxiii, 319-320.

From mechanical analogy, the author regards the dead point as being that stage in which the curative process and the pathological condition are in equilibrium so that the disease remains stationary.

In radiation therapy this dead point is claimed to be easily reached if heavy doses of rays are administered. Such doses whip up the curative process, but at the same time they inflict injury which nullifies the favorable effect. For instance, if a dormant tuberculous skin ulcer is given a strong dose (10 to 20 X) of highly filtered roentgen rays, the immediate effect may be a rapid decrease in size of the ulcer. If the same dose is repeated in a short time, the curative process is stopped at the "dead point" and further treatments of the same kind are without effect. Such an ulcer becomes more and more obstinate to treatment and finally becomes incurable. If, on the other hand, the original dose of 10 to 20 X is delivered in ten to twenty fractions at weekly intervals there is produced an acceleration of the curative and defensive powers of the tissue resulting in a cure without the slightest subsequent change in the surrounding healthy skin.

An analogous situation is to be found in the application of ultraviolet therapy.

WEBSTER, J. H. D. Radiation treatment in exophthalmic goitre. *Brit. M. J.*, June 12, 1926, i, 985–986.

Radiation is one of the few therapeutic measures which have stood the test of time. It stands well in the forefront among the 239 different drugs and remedies for the disease which were compiled by Marine.

Surgery had a thirty-year start of radiology in the treatment of exophthalmic goiter, but thyroid surgery has been fortunate in remaining almost entirely in the province of experts, whereas anyone who has access to an apparatus can give roentgen-ray treatment. Moreover roentgen dose measurements passed the elementary stage only in the last fifteen or twenty years, hence the many failures charged to roentgen rays. It is regrettable that books such as Crile's and Crotti's are still disfigured with pictures of roentgen-ray burns on the neck. Such photographs are as meaningless now as old operation statistics would be.

The author's own experience extends to 168 cases some of which have not been followed up. There were 88 cases out of 107 which showed marked improvement, a percentage (82) similar to that reported by other radiologists. Lately the author has employed a technique which attempts to half saturate the thyroid with cumulative doses in the first month or two and then as progress is established the intervals between treatments have been gradually increased to months. In this way a number of patients have been restored to health with only about 2.5 H to each side of the thyroid, if large, or to the whole gland from one or the other side if small, repeated in five to eight treatments in all, taking two to four months for great relief or for cure. For very small thyroids a 1 mm. Al filter is used, and for moderately enlarged ones 3 to 4 mm. Al; and for large, hard glands 0.5 mm. Zn is employed. In each instance there is administered about one-half to two-thirds of the dose which will produce an erythema on the sensitive skin of the exophthalmic patient, whose erythema dose is about 60 to 70 per cent that of the small erythema dose for an average skin.

The nervous symptoms are usually the first to improve after irradiation. Benefit is sometimes noted after one treatment. The exophthalmos and thyroid enlargement remain to some degree in most of the long standing cases. In more acute cases not supervening on an old goiter, the eye symptoms and thyroid enlargement may become normal. The author irradiates the thymus only when there is not the expected response after irradiation of the thyroid or when there is present marked myasthenia, gross tremor, lymphocytosis with leucopenia and amenorrhea, added to a predominantly vagotonic type, all suggesting the presence of a considerable thymic element.

MISCELLANEOUS

OPITZ. On the radiation biology of carcinoma. *Brit. J. Radiol.*, July, 1925, XXX, 252–264.

It is only the mutual action and reaction of every cell and the entire organism that can throw light on what takes place biologically when a cancer is subjected to irradiation. To that end it is necessary to form a few general ideas regarding the biology of cancer. It has been the author's view that we cannot learn anything of the nature of cancer from histological microscopic preparations alone. All that is seen is a superfluous growth of epithelial cells increasing without limit and having the power of penetrating neighboring cells. The phenomenon shows that a war is being waged by the organism against cells not belonging to that region which are endeavoring to force an entrance, like so many foreign bodies, with a decidedly unfavorable result to the host.

There is apparently what may be termed a disposition to cancer, and this disposition is increased with age, although cancer is rather less a disease of age than of aging.

Experimental study of the effects of radiation on cancer show that for a favorable effect a prerequisite is the presence of connective tissue in sufficient quantity and suitable quality and associated with a correct strength of rays. If the dose is insufficient the desired end is not attained. If the dose is too great degenerative retrogressive transformations take place but so rapidly that the desired removal of the epithelial cells is not brought about. Details are still uncertain, especially regarding the parts played by the different tissue elements. All that seems certain to the author is that in earlier research histiocytes were frequently taken for lymphocytes.

In addition to the local effect there is a general effect derived from the use of hard rays. Many of the changes brought about by irradiation have a mutual effect upon one another. Thus cholesterin content, blood count and fluidity stand clearly in relation to one another. That chemical changes also play a part is self-evident. The nervous and chemical changes produce an effect on the locus of reaction, and they are considered important.

The various processes surrounding cancer are really no more than a defensive reaction due to unlocalized stimulative treatment. If

this is correct two ways lie open for the improvement of roentgen therapy: (1) the influencing of the connective tissue by a general stimulation, and (2) an influencing of the nervous system and the connected blood glands and blood-forming centers in the sense of an indirect stimulus of the reticulo-endothelial apparatus.

PEEMÖLER, FR. Biological effects of light upon man in health and disease, with special regard to rickets. *Strahlentherapie*, 1925, XX, 865–913.

This is an extensive review of the subject accompanied by a bibliography of several hundred references.

The author's studies show that the results of artificial heliotherapy in rickets are dependent primarily upon the erythema-producing rays with a wave length less than 320μ. Maximum erythema is produced by radiation of about 300μ. Heat rays apparently act only secondarily in rickets by supporting the ultraviolet rays. They are unable to induce recovery independently.

For an efficient treatment of rickets and skin tuberculosis adequate sources of the erythema-forming rays are necessary. The best sources are the quartz mercury vapor lamps.

It appears that pigmentation does not necessarily run parallel with erythema production, and it would seem that radiations with greater wave length than 320μ and even the darker heat rays are able to produce pigmentation.

Any procedure that is able to produce a hyperemic effect upon the skin appears able to augment the effect of the erythema-producing radiations. The pigment does not seem to protect against ultraviolet rays, and it is the author's opinion that it is merely a protection against the penetration of luminous rays by preventing heat congestion.

There seems to be no justification for assuming a localized, specific skin immunity against certain ultraviolet rays (as Perthes believes). The protective action of the skin against radiation is characterized by certain processes that can be seen microscopically either as a thickening of the corium and germinal layers or as a swelling of the prickle cell layer.

Among the other effects of light, especially ultraviolet light, is the influence upon blood regeneration, upon the leucocyte picture, circulation and respiration. There is moreover an important effect upon the protein metabolism; depending upon the intensity, there is either a protein synthesis or breakdown. The carbohydrate metabolism is affected in the sense that the blood sugar level is considerably lowered; and in many cases of diabetes the urinary sugar may disappear. An influence is also exerted more or less upon the fat, calcium, phosphorus and salt metabolism. Certain animal experiments would indicate that heliotherapy induces an increased fermentative activity in the blood.

Heat irradiation has been found to destroy diphtheria toxins in animals; and typhoid agglutinins in man have been increased. The effect of light in skin immunity toward tuberculosis has not been adequately investigated.

The nervous system is affected in different ways by light. Many of the effects above noted, as for instance, the change in the blood picture, the increase in respiratory metabolism and in the type of respiration, have been observed. Generally speaking, the effect of light upon the nervous system depends upon the wave length and the intensity of the rays.

O'HARE, JAMES P.; ALTNOW, HUGO; CHRISTIAN, THOMAS D JR., CALHOUN, ABNER W., and SOSMAN, M. C. Chronic nephritis produced by *x*-ray. *Boston M. & S. J.*, Jan. 14, 1926, CXCIV, 43–45.

Numerous investigators have attempted by various means to produce a suitable progressive sclerosis of the kidneys in experimental animals. None of the methods, however, has produced a satisfactory lesion suitable for use in the study of the problem of chronic nephritis. The authors suggest the use of roentgen rays as a suitable method. A report is made on a series of 28 rabbits. In each animal, under ether anesthesia, the right kidney was brought up into a flank incision and exposed to a roentgen dose varying from two to ten times the erythema dose. A few animals died but most of them survived to be killed later. The duration of life varied from one day to five months after roentgen treatment. At autopsy it was possible to compare the irradiated and normal kidneys. In the animal that died twenty-four hours after exposure there was acute degeneration of the affected kidney.

With the higher dose and greater prolongation of the experiment chronic changes developed. In the gross, there was definite decrease in the size of the irradiated kidney. Slight thickening of the small arteries, gradual destruction of tubules, thickening of Bowman's capsule, occasionally a damaged glomerular tuft and a moderate amount of connective tissue appeared. Prolonging the experiment for three or more months resulted in progressive decrease in size of the kidney to half that of the control. In these advanced cases there is a marked sclerosis of the kidney, the vessels are thickened and the tubules are to a large extent destroyed or undergoing degeneration. The glomeruli, though less affected, show capsular

thickening, sclerosis of some tufts and other changes. Connective tissue is very prominent and there is some cellular infiltration.

Such a controlled lesion should throw much light on the problem of chronic hypertensive nephritis in man.

ZISKIN, THOMAS. Development and size of the heart in children. *Am. J. Dis. Child.*, December, 1925, xxx, 851–855.

A study was made of the hearts of children by means of the teleroentgenogram. The present investigation was undertaken for the purpose of studying the normal measurements of children's hearts and their relation to body growth. The teleroentgenograms were taken at a distance of 6 feet with the patient in the vertical position. The phase of respiration was considered a negligible factor. The cases were classified both according to the height and age and the following measurements were made from the roentgenograms: (1) Distance from the midline to the most distant right border; (2) distance from the midline to the most distant left border; (3) sum of the first two, taken as the transverse diameter; (4) the maximum long diameter measured from the auricular notch to the most distant apical border; (5) the maximum broad diameter measured at right angles from the long diameter to the most distant borders above and below; (6) diameter of the aortic arch; (7) the angles formed by the transverse and long diameters; (8) the maximum internal diameter of the chest; (9) the ratio of the transverse diameter to the internal chest diameter; (10) the ratio of the median right diameter to the median left diameter.

Tables and charts are given showing the development and relative measurements of the heart at different ages and different heights. The ratio between the transverse diameter of the heart and the internal chest diameter diminishes slightly as the child develops. This is due to the change in the position of the heart.

The right border of the heart does not extend relatively further to the right in childhood. There is a constant ratio between the median right diameter and the median left diameter of the heart. This is approximately 50 per cent at all ages and heights.

POHLE, ERNST A. Studies on the suspension-stability of the human blood. II. The changes of the sedimentation rate of the erythrocytes *in vitro* and *in vivo* after *x*-ray exposure. *Radiology*, January, 1926, vi, 55–58.

Irradiation of the human blood in capsules with unfiltered roentgen rays influences the blood suspension-stability. A certain minimum dose is required to cause a definite retardation of the sedimentation velocity of the erythrocytes. The sedimentation test is a reversible reaction; it can be reproduced qualitatively but not quantitatively. Certain precautions have to be observed to give reliable results.

The procedure employed was to fill two pipettes at the same time with blood from an individual, one pipette being irradiated and the other used as a control. Only normal individuals who had never been subjected to roentgen treatments were chosen. The radiations employed were produced by a 9 in. spark gap (ca., 135 kv.), 5 ma., no filter, 30 cm. distance. The dose varied from 100 to 500 S.U.D.

PORDES, FRITZ. On the visibility of the liver, gall-bladder and urinary bladder in the ordinary roentgenogram. *Fortschr. a. d. Geb. d. Rontgenstrahlen*, 1925, xxxiii, 690–692.

Apart from the well-defined shadows given by calcium, metals and contrast materials in the body, there are three intensities of shadow produced by normal structures: (1) the rarefaction due to gas; (2) the shadow intensity characteristic of fat, and (3) the shadow intensity characteristic of the other soft tissues. In the case of gall-bladder with a thickened wall (but not containing concrements) there should be still a fourth shadow intensity somewhat more dense that that due to ordinary soft tissues.

Very frequently one observes in a pelvic roentgenogram a structure immediately over the symphysis which represents the urinary bladder. The reason why the normal bladder produces a shadow distinct from the rest of the normal contents, without gas in the intestines, lies in the fact that the normal abdominal contents are specifically lighter than the urinary bladder with its contents. The difference certainly does not lie in the difference in shadows produced by the intestinal and bladder walls.

Numerous complete barium enemas have given roentgenoscopic evidence of the surprising fact that there is in practically all normal cases a certain amount of gas rarefaction in the small intestine. In other words, distinct quantities of gas in the small intestine are a normal finding; and the active peristalsis of this organ makes the intestinal contents foamy.

It is concluded from these observations that the visibility of the lower surface of the liver, of the gall-bladder and of the urinary bladder is not because the walls have become

thickened but simply because their surroundings, namely, the gassy intestinal contents and the fatty mesentery, furnish a roentgenographic contrast. These organs are not denser than other parenchymatous structures. Interpretation of roentgenograms of the gall-bladder region should be made with great care because a good technique and brief exposure may yield accidental intestinal gas rarefactions that can easily be mistaken for gall-bladder shadows. Only repeated roentgenograms taken at different intervals can furnish useful information.

REINBERG, SAM. A. Roentgen studies of the normal and pathologic physiology of the tracheobronchial tree. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 661–672.

The author reports on the results of a two-year experience with the intratracheal injection of lipiodol and bismuth suspensions, attention being paid mainly to the hitherto unknown features of the motility of the bronchial walls. This procedure permitted the discovery for the first time of peristaltic muscular contractions of the tracheobronchial wall in man. Many confirmatory experiments were done upon the goose, an animal admirably suited for the purpose.

In man the movements of the trachea and bronchi are complicated and very manifold. These movements are classified as passive and active. The passive movements comprise the pulsations transmitted from the heart and the larger vessels and the motions due to respiration. The active movements consist of tonic and peristaltic movements of the wall. In addition there are the movements of the bronchial contents due to the ciliary epithelium and the cough reflex.

The reontgenological observations show that the human is enabled to get rid of secretions and foreign material not only through the activity of the ciliary epithelium and the cough reflex but also the active peristalsis of the smooth tracheobronchial musculature. This constitutes another very important mechanism for natural pulmonary drainage.

Interesting observations were made on the origin of the cough reflex. It was found that bismuth suspension could be allowed to run into the bronchi of the fifth, fourth and third orders without any reaction on the part of the patient. Coughing, however, occurred promptly when the bismuth reached the hilic region and entered the bronchi of the first and second orders. The contrast material is ejected from the peripheral bronchi not by the rather slowly acting ciliary epithelium but by the energetic peristaltic waves induced.

The pathological studies were confined practically entirely to bronchiectasis. There was found a considerable functional insufficiency of the diseased portion of the bronchial tree in patients with bronchiectasis. As a consequence there is an insufficiency in pulmonary drainage. The conclusion is reached that bronchiectases appear only when the bronchial walls have undergone injury.

ROFFO, A. H., and CORREA, L. M. On the changes produced by roentgen rays in cholesterol. *Strahlentherapie*, 1925, xx, 574–575.

The assumption of a simple isomeric change in cholesterol by the action of roentgen rays is excluded because the resulting products do not give the color reactions that would be expected. The product loses its power of crystallization and this is considered of great importance.

The effect of the roentgen rays on cholesterol is, first, to make it lose certain color reactions although addition of bromine is still possible. This indicates the formation of a double addition compound which later disappears. During this process the reaction of the medium becomes more acid. The resulting material has been subjected to elementary analysis, and this shows that the action of the roentgen rays consists in the oxidation of the molecule, a process that increases its acidity. If the Windaus formula of the structure of cholesterol is accepted, this effect of irradiation must take place at the carbon atom with the formation of an alcohol.

SAHATSCHIEFF., A On the roentgen examination of the heart. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 683–690.

The roentgen examination of the heart gives information only regarding the size and form of the heart. The diagnostic value of this information depends upon the accuracy of determination, and the ordinary roentgen examination of the chest with the tube 60 to 70 cm. distant yields an enlarged and deformed heart shadow, i.e., its central projection. An analysis of the results yielded by orthodiagraphy and teleroentgenography reveals that the main error of these methods lies in the fact that they give no information regarding the shape of the heart from all directions including the horizontal projection.

The author has endeavored to improve the roentgenological technique so that information may be obtained regarding the shape of the heart in the horizontal projection. A transverse section of the chest between the seventh and eighth thoracic vertebrae shows the normal heart to possess a fairly smooth ovoid form. In this position the left end of the ovoid cor-

responds to the external walls of both left chambers, while the right end corresponds to the right auricle. The front segment of the ovoid bounds the right ventricle and the posterior segment the left. This ovoid can be located for practical purposes by means of three pairs of tangents. The first pair touch both edges of the heart and run parallel to the median plane. The second pair run diagonally from the left side in front toward the right in back, the angle being so chosen that the posterior of this pair of parallel tangents touches both the heart outline and the anterior edge of the spine. The third pair of tangents run from the left back toward the right front and their direction is determined in the same manner as the last pair of oblique tangents. The intersections of these six tangents produce an irregular hexagon which incloses the heart projection.

To determine the horizontal cross section of the heart upon the patient the author has made use of an apparatus designed for localizing foreign bodies. In the examination of the patient the above six tangents are determined at a level a little above the mammary line and the points of entry and exit are marked upon the screen from these points. A sketch may be made of the heart outline from which important information may be obtained, especially in insufficiency and stenosis of the mitral value, aortic insufficiency with decompensation, aortic, stenosis, Stokes-Adams disease, mitral insufficiency and stenosis with decompensation, both advanced and incipient.

SAMUEL, MAX. Radiation injuries. *Münchcn. med. Wchnschr.*, July 31, 1925, lxxii, 1296–1297.

A case is cited in a scientist who showed a condition of aspermia. Eight months after the first examination a few motile spermatozoa were observed in his seminal fluid. Investigation showed that the patient had previously been working with roentgen rays and was unaware of their sterilizing action. The author points out that apparatus for generating roentgen rays is now freely available and is frequently used in lecture halls and other places where the general public may be inadvertently exposed. He suggests that some means of legal control over the operation and distribution of roentgen apparatus should be instituted for public protection.

A second case of radiation injury occurred in a woman who was treated by a well-known radiologist with roentgen and radium rays. Eight or nine months after the treatment there appeared multiple hemorrhagic erosions of the rectum. In 2 other cases the introduction of radium for total extirpation of carcinoma caused the development of a funnel-shaped necrosis in the vagina. An explanation of these necroses is hard to give because other cases did not show these injuries after exactly similar treatment.

SCHNEIDER, ERICH. Studies on the effect of roentgen rays upon yeast. II. *Strahlentherapie*, 1925, xx, 793–812.

Yeast was dried and exposed to roentgen rays, and it was subsequently tested for its fermentative ability. The results show no notable changes in the fermentative powers. When the yeast was irradiated during the fermentation test, there was observed a slight bionegative effect of the roentgen rays. The effect of the roentgen rays seems to be conditioned by the nature of the surrounding medium; because it is only when electrolytes are present that a positive effect is observed.

These observations seem to confirm the thesis of Groedel that the dead or inactive cell does not respond to roentgen irradiation. The action of roentgen rays is dependent on the activity of the cell and is greater, the greater the functional activity of the cell. Even unicellar organisms are roentgen-sensitive when they are irradiated in a suitable photoynamic environment.

The roentgen rays in the above experiments were produced with a Müller self-hardening tube, operated at 2 ma., 104 Sclerometer. The exposures were made without filter for one-half hour and corresponded to a dose of three skin units at the surface. The surface focal distance was 26 cm.

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